MOTOROLA

MOSTAR™

FM Two-Way Trunked Radios

Transmit: 806-825 MHz
Receive: 851-870 MHz
15 W RF Power

Instruction Manual

68P81062E65-A

COMMERCIAL WARRANTY
(STANDARD)

Motorola radio communications products are warranted to be free from defects in material and workmanship for a period of ONE (1) YEAR, (except for crystals and channel elements which are warranted for a period of ten (10) years) from the date of shipment. Parts, including crystals and channel elements, will be replaced free of charge for the full warranty period but the labor to replace defective parts will only be provided for One Hundred-Twenty (120) days from the date of shipment. Thereafter purchaser must pay for the labor involved in repairing the product or replacing the parts at the prevailing rates together with any transportation charges to or from the place where warranty service is provided. This express warranty is extended by Motorola Communications and Electronics, Inc., 1301 E. Algonquin Road, Schaumburg, Illinois 60196, to the original purchaser only, and only to those purchasing for purpose of leasing or solely for commercial, industrial, or governmental use.

THIS WARRANTY IS GIVEN IN LIEU OF ALL OTHER WARRANTIES EXPRESS OR IMPLIED WHICH ARE SPECIFICALLY EXCLUDED, INCLUDING WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. IN NO EVENT SHALL MOTOROLA BE LIABLE FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES TO THE FULL EXTENT SUCH MAY BE DISCLAIMED BY LAW.

In the event of a defect, malfunction or failure to conform to specifications established by seller, or if appropriate, to specifications accepted by Seller in writing, during the period shown, Motorola, at its option, will either repair or replace the product or refund the purchase price thereof, and such action on the part of Motorola shall be the full extent of Motorola's liability hereunder.

This warranty is void if:

a. the product is used in other than its normal and customary manner;
b. the product has been subject to misuse, accident, neglect or damage;
c. unauthorized alterations or repairs have been made, or unapproved parts used in the equipment.

This warranty extends only to individual products, batteries are excluded, but carry their own separate limited warranty. Because each radio system is unique, Motorola disclaims liability for range, coverage, or operation of the system as a whole under this warranty except by a separate written agreement signed by an officer of Motorola.

Non-Motorola manufactured products are excluded from this warranty, but subject to the warranty provided by their manufacturers, a copy of which will be supplied to you on specific written request.

In order to obtain performance of this warranty, purchaser must contact its Motorola salesperson or Motorola at the address first above shown, attention Quality Assurance Department.

This warranty applies only within the United States.

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MOSTAR TECHNICAL INNOVATIONS

The *Mostar* FM Two-Way Trunked Mobile Radios described in this instruction manual incorporate the latest technological state-of-the-art advancements for mobile radio communications.

These mobile radios are MICROCOMPUTER CONTROLLED units that utilize state-of-the-art frequency synthesis to generate all of the required transmit and receive frequencies. The sophisticated microcomputer system is designed to simplify radio operation by the elimination of manual frequency selection, squelch control, and monitoring requirements.

The solid-state, COMPACT, MODULAR DESIGN of these mobile radios is partly due to extensive use of both resistor and capacitor chip components used on the circuit boards contained in the radio set. CHIP COMPONENTS require special servicing techniques which are outlined in the Maintenance section of this instruction manual.

FREQUENCY SYNTHESIS allows specific radio frequencies to be generated electronically, instead of using crystals or channel elements. This simplifies multiple-frequency operation since frequencies can be changed or added simply by inserting a different code plug.

The *Mostar* Trunked radio sets are interactive members of the Motorola Trunked Radio System which operates over the entire 800 MHz frequency spectrum. Since frequencies can be added or changed without retuning or realigning the radio set, the unit CAN OPERATE in different systems ON WIDELY SEPARATED FREQUENCIES.

MOTOROLA INC.
Communications Sector

MOSTAR
FM TWO-WAY TRUNKED RADIOS

TRANSMIT: 806-825 MHz
RECEIVE: 851-870 MHz
15 W RF POWER

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technical writing services
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FOREWORD

1. SCOPE OF MANUAL

This manual is intended for use by experienced technicians familiar with similar types of equipment. It contains all service information required for the equipment described and is current as of the printing date. Changes which occur after the printing date are incorporated by Instruction Manual Revisions (SMR). These SMR's are added to the manuals as the engineering changes are incorporated into the equipment.

2. MODEL AND KIT IDENTIFICATION

Motorola equipments are specifically identified by an overall model number on the nameplate. In most cases, assemblies and kits which make up the equipment also have kit model numbers stamped on them. When a production or engineering change is incorporated, the applicable schematic diagrams are updated.

3. SERVICE

Motorola's National Service Organization offers one of the finest nation-wide installation and maintenance programs available to communication equipment users. This organization includes approximately 900 authorized Motorola Service Stations (MSS) located throughout the United States, each manned by one or more trained, FCC licensed technicians.

These MSS's are independently owned and operated and were selected by Motorola to service its customers. Motorola maintenance is available on either a time and material basis or on a periodic fixed-fee type arrangement.

The administrative staff of this organization consists of national, area and district service managers and district representatives, all of whom are Motorola employees with the objective to improve the service to our customers.

Should you wish to purchase a service contract for your Motorola equipment, contact your Motorola Service Representative, or write to:

National Service Manager
Motorola Communications and Electronics, Inc.
1303 E. Algonquin Road
Schaumburg, Illinois 60196

REPLACEMENT PARTS ORDERING

ORDERING INFORMATION

Motorola maintains a number of parts offices strategically-located throughout the United States. These facilities are staffed to process parts orders, identify part numbers, and otherwise assist in the maintenance and repair of Motorola Communications Sector products.

Orders for all parts *except* crystals, active filters, channel elements, and "Vibrasender" ® and "Vibrasponder" ® resonant reeds should be sent to the nearest area parts center. Orders for instruction manuals should also be sent to the area parts center.

When ordering replacement parts or equipment information, the complete identification number should be included. This applies to all components, kits, and chassis. If the component part number is not known, the order should include the number of the chassis or kit of which it is a part, and sufficient description of the desired component to identify it.

Orders for crystals, channel elements, active filters, and reeds should be sent to the Component Product Sales & Service address listed below. Crystal and channel element orders should specify the crystal or channel element type number, crystal and carrier frequency, and the chassis model number in which the part is used.

Orders for active filters, *Vibrasender* and *Vibrasponder* resonant reeds should specify type number and frequency, should identify the owner/operator of the communications system in which these items are to be used; and should include any serial numbers stamped on the components being replaced.

COMPONENT PRODUCT SALES & SERVICE OFFICE

All Mail Orders
Motorola, Inc.
Component Product Sales & Service
P.O. Box 66191, O'Hare International Airport
Chicago, IL 60666

Correspondence
Motorola, Inc.
Component Product Sales & Service
2553 N. Edgington Street, Franklin Park, IL 60131
Tel: 312-451-1297, TWX: 910-227-0799, Telex: 433-0067

AREA PARTS OFFICES

Western Area Parts
1170 Chess Drive, Foster City, CA 94404
Tel: 415-349-8621, TWX: 910-375-3877

Pacific-Southwestern Area Parts
P.O. Box 85036, San Diego, CA 92138
Street Address:
9980 Carroll Canyon Road, San Diego, CA 92131
Tel(619-578-8030, TWX: 910-335-1516

Gulf States Area Parts
P.O. Box 73115, 1140 Cypress Station, Houston, TX 77090
Tel: 713-537-3636, TWX: 910-881-6392

Southwestern Area Parts
P.O. Box 34290, 3320 Belt Line Road, Dallas, TX 75234
Tel: 214-620-8511, TWX: 910-860-5505

Midwest Area Parts
1313 E. Algonquin Rd., Schaumburg, IL 60196
Tel: 312-576-7430, TWX: 910-693-0869

Southeastern Area Parts
P.O. Box 368, Decatur, GA 30031
Street Address:
5096 Panola Industrial Blvd., Decatur, GA 30032
Tel: 404-987-2232, TWX: 810-766-0876

Rocky Mountain Area Parts
20 Inverness Place East, Englewood, CO 80122
Tel: 303-790-2323, TWX: 910-935-0785

East Central Area Parts
12955 Snow Road, Parma, OH 44130
Tel(216-433-1560, TWX: 810-427-9424

Eastern Area Parts
85 Harristown Road, Glen Rock, NJ 07452
Tel: 201-447-4000, TWX: 710-988-5614

Mid-Atlantic Area Parts
7230 Parkway Drive, Hanover, MD 21076
Tel: 301-796-8763, TWX: 710-862-1941

National Accounts
Railroad, Airlines, and Telephone Sales
1313 E. Algonquin Rd., Schaumburg, IL 60196
Tel: 312-576-6512, TWX: 910-693-0869

All Canadian Orders
Motorola, Ltd., National Parts Department
3125 Steeles, Ave. E., Willowdale, Ontario M2H 2H6
Tel: 416-499-1441, TWX: 610-491-1032,
Telex: 06-526258

National Data Services

1171 West 17th Street, Tempe, AZ 85281
Tel: 602-994-6472, TWX: 910-951-1334

All Countries Except U.S. & Canada

Motorola, Inc., International Parts Department
1313 E. Algonquin Rd., Schaumburg, IL 60196. U.S.A.
Tel: 312-576-7241, TWX: 910-693-0869
Telex: 722443, Cable: MOTOL PARTS

MOTOROLA INC.
Communications
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GENERAL SAFETY INFORMATION

The United States Department of Labor, through the provisions of the Occupational Safety and Health Act of 1970 (OSHA), has established an electromagnetic energy safety standard which applies to the use of this equipment. Proper use of this radio will result in exposure below the OSHA limit. The following precautions are recommended:

DO NOT operate the transmitter of a mobile radio when someone outside the vehicle is within two feet (0.6 meter) of the antenna.

DO NOT operate the transmitter of a fixed radio (base station, microwave and rural telephone rf equipment) or marine radio when someone is within two feet (0.6 meter) of the antenna.

DO NOT operate the transmitter of any radio unless all RF connectors are secure and any open connectors are properly terminated.

In addition,

DO NOT operate this equipment near electrical blasting caps or in an explosive atmosphere.

All equipment must be properly grounded according to Motorola installation instructions for safe operation.

All equipment should be serviced only by a qualified technician.

Refer to the appropriate section of the product service manual for additional pertinent safety information.

WARNING

For vehicles equipped with electronic anti-skid braking systems see "ANTI-SKID BRAKING PRECAUTIONS" Publication, Motorola Number 68P81109E34.

SAFETY INFORMATION FOR RADIOS INSTALLED IN VEHICLES POWERED BY LIQUEFIED PETROLEUM (LP) GAS

WARNING

It is mandatory that radio installations in vehicles fueled by liquefied petroleum gas conform to the following standard.

National Fire Protection Association standard NFPA 58 applies to radio installations in vehicles fueled by liquefied petroleum (LP) gas with the LP-gas container in the trunk or other sealed-off space within the interior of the vehicles. This standard requires that:

1. Any space containing radio equipment shall be isolated by a seal from the space in which the LP-gas container and its fittings are located.
2. Remote (outside) filling connections shall be used.
3. Venting of the container space to the outside shall be provided.

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11/15/81- PHI
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PERFORMANCE SPECIFICATIONS FOR TRUNKED *MOSTAR* 15 WATT FM RADIO

GENERAL

No. of Channels or Frequency Pairs	Twenty
Primary Power	12 V dc negative ground.
Dimensions	2.0" H x 7.0" W x 9.5" L (51 mm x 178 mm x 242 mm)
Weight	Approximately 6.25 lbs. (2.84 kg).
Metering	A single-scale 0-50 microampere meter or Motorola portable test set can be used to measure all circuits essential to checking and adjustments.

Frequency (MHz)	Intermittent Minimum RF Power Output	Operation	Maximum Battery Current Drain (With No Options) Standby @13.8 V	Receiver @13.8 V	Transmitter @13.6 V
TX: 806-825 RX: 851-870	15 W	+12 V dc	650 mA	1.2A	6.5A

TRANSMITTER

Output Impedance	50 ohms
Spurious and Harmonic Emissions	More than 56 dB below carrier (for EIA spec., RS152B)
Frequency Stability	± .00025% of assigned center frequency from -30 °C to +60 °C ambient (+25 °C reference)
Modulation	15F2 & 16F3, ±5 kHz for 100% @1000 Hz
Audio Sensitivity	0.080 V ±3 dB for 60% maximum deviation @1000 Hz
Audio Response	+1, -3 dB of a 6 dB/octave pre-emphasis characteristic from 300 to 3000 Hz
Audio Distortion	Less than 3% @ 1000 Hz, 60% maximum deviation
Maximum Frequency Separation	19 MHz

RECEIVER

Channel Spacing	25 kHz
Sensitivity: 20 dB Quieting EIA SINAD	 .40 uV .30 uV
Selectivity: EIA SINAD	-75 dB @ ±25 kHz
Spurious and Image Rejection	-80 dB
Intermodulation: EIA SINAD	-75 dB
EIA Modulation Acceptance	±7.0 kHz minimum
Input Impedance	50 ohms
Audio Output	3 watts at less than 5% distortion (into a 4 ohm load)
Maximum Frequency Separation	19 MHz
Frequency Stability	± .00025% of assigned center frequency from -30 °C to +60 °C ambient (+25 °C reference)

SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE

FCC TRANSCEIVER DESIGNATION

RF Output	Five and 20 Channels
15-Watts	ABZ89FT5619

MODEL CHART

FOR

MOSTAR

FM TWO-WAY TRUNKED RADIOS

1 SYSTEM, 1 SUBFLEET

806-870 MHz

15 W RF POWER

+ 12 V DC MOBILE

CODE:

● = ONE ITEM SUPPLIED

★ = REFER TO UNIFIED CHASSIS BREAKDOWN CHART

MODEL	DESCRIPTION	RF POWER
D35TLA5G00CK	20-CHANNEL	15 W

ITEM	DESCRIPTION
HKN4120A	MOBILE POWER CABLE
HLN4381A	PROM KIT
HLN4383A	HOUSING KIT
HLN4410A	HARDWARE KIT
HLN4426A	INSTALLATION KIT, LOCKING TRUNNION
HLN4433A	MICROPHONE HANG-UP CLIP
HLN4449A	HARDWARE, VOLUME SET
HMN1001A	MICROPHONE, CARRIER SQUELCH
★ HUF1016C	TRUNKED UNIFIED CHASSIS
RRA4910A	ANTENNA, ROOF (WITH SPRING)

EPS-35479-B

TRUNKED UNIFIED CHASSIS
BREAKDOWN CHART
FOR
MOSTAR
FM TWO-WAY TRUNKED RADIOS
806-870 MHz

CODE:

● = ONE ITEM SUPPLIED

MODEL		DESCRIPTION
HUF1016C	HUF1017B	
●	●	HLF1017A POWER AMPLIFIER ASSEMBLY
●	●	HLF4064A PA CIRCUIT BOARD
●	●	HLN4386A PA HARDWARE KIT
●	●	HLF1019B 800 MHz CHASSIS ASSEMBLY
●	●	HLF4063B MAIN CIRCUIT BOARD
●	●	HLN4385A CHASSIS HARDWARE
●	●	HLF4080A TRUNKED COMMAND CIRCUIT BOARD
●	●	HLN4489A HARDWARE KIT
●		HLN4706A MICROPROCESSOR KIT
	●	HLN4707A MICROPROCESSOR KIT

EPS-35480-B

Trunked Mostar 800 MHz Radio Set Options Table

Option	Description	Kit Added	Kit Deleted	Reference Publication
B18AG	External Speaker	HLN4594A HSN4013A	HLN4544A	68P81109E24
B20BC	Telephone Interconnect (Mobile)	HLN4443A HMN1010A HUF1017B	HLN4449A HMN1001A HUF1016C	68P81114E07
B20BJ	Telephone Interconnect (Base)	HLN4443A HMN1010A HUF1017B	HLN4449A HMN1005A HUF1016C	68P81114E07
B22AM	Palm Microphone (Base)	HMN1001A	HMN1005A	Note 1
B29AB	Quick Mount Screws	HLN4437A		Note 1
B58AC	1/4 Wave Antenna	RRA4911A	HAF4000A RRA4910A	68P81048E40
B62AD	Security Screws	HLN4438A		Note 1
B80AB	Non-Lock Mount	HLN4427A	HLN4426A	Note 1
B109BM	Handset and Hangup Cup (Mobile)	HLN4432A HMN4007A	HMN1001A	68P81112E64
B109BP	Handset and Hangup Cup (Base)	HLN4432A HMN4007A	HMN1005A	68P81112E64
B113AG	Ignition Switch Cable	HKN4121B		68P81113E98
B116AC	External Alarm	HLN1128A HLN4441A		Note 1
B239AH	Noise Cancelling Microphone (Mobile)	HMN4008A	HMN1001A	68P81112E84
B239AL	Noise Cancelling Microphone (Base)	HMN4008A	HMN1005A	68P81112E84
B305AA	3 Multi-System Access	HLN4412A	HLN4410A	68P81112E85
B305AB	3 Multi-System Access (Subfleet)	HLN4414A		68P81112E85
B308AA	Options Connector	HLN4472A		Note 1
B330BZ	Public Address	HKN4132A (3) HKN4149A HLN4442A HSN1000A		68P81112E86
B346AC	Multi-Subfleet/Multi-System	HLN4413A	HLN4410A	68P81112E88
B346AD	Multi-Subfleet	HLN4411A	HLN4410A	68P81112E88
B488AA	A/B Receive Audio Switch with 5 W Speaker	HLN4495A HSN4013A		68P81112E86
B589BZ	Public Address with Internal/External PA Switch	HKN4132A (4) HKN4149A (2) HLN4442A HLN4444A HSN1000A (2)		68P81112E86
B657AF	Quick Disconnect Mount	HLN4431A	HLN4426A	68P81112E32
B665AD	Control Station Operation	HKN4122A HLN4474A HMN1005A HMN1004A	HKN4120B HLN4426A HMN1001A RRA4910A	68P81113E94
B687AF	*Call Alert* Decode			Note 1
B699AA	Multiple *Call Alert* Encode (6 Systems)	HLN4413A HLN4560A		Note 1
B699AB	Multiple *Call Alert* Encode (8 Subfleets)	HLN4411A HLN4560A	HLN4410A	Note 1
B700AA	Public Address with A/B Receive Audio Switch	HKN4132A (3) HKN4149A HLN4442A HLN4495A HSN1000A HSN4013A		68P81112E86
B704AA	*Private Conversation*	HLN4440A		Note 1
B705AA	Multiple *Private Conversation* Capability with *Call Alert* Encode	HLN4411A HLN4440A	HLN4410A	Note 1
B709AA	Multiple Systems (6)	HLN4412A HLN4256A	HLN4381A HLN4410A	Note 1

Note 1: Covered in this publication.

1. INTRODUCTION

The Trunked *Mostar* FM Two-Way Mobile Radio is a microcomputer controlled unit utilizing all solid-state circuitry and state-of-the-art frequency synthesis to generate all required transmit and receive frequencies. The Trunked *Mostar* Radio is an interactive member of the Motorola Trunked Radio System which functions in the 800 MHz frequency spectrum.

2. TRUNKED *MOSTAR* RADIO FEATURES

2.1 STANDARD FEATURES

The Trunked *Mostar* Radio provides the following features:

- microcomputer control
- broad-band operation
- frequency synthesis
- improved transmitter and receiver performance
- wide operating temperature range (from −30°C to +60°C)
- all solid-state, compact, modular design that simplifies radio maintenance and troubleshooting
- programmable time-out timer

Some of these features are discussed in the following paragraphs.

2.1.1 Microcomputer-Control

Most major radio set operations are controlled by an 8-bit microcomputer, a read only memory (ROM) that contains the operating program, and associated support and control logic. This sophisticated microcomputer system is designed to simplify mobile operation by elimination of manual frequency selection, squelch control, and monitoring requirements.

All unique user-specified operating parameters are contained in the code plug PROM. This permits the radio to be easily customized to meet specific user requirements. Operational modifications are implemented by simply replacing the existing code plug with one that has been programmed according to the user's requirements. Consequently, a Trunked *Mostar* Radio can be easily moved between fleets in a Motorola Trunked Radio System having different operating parameters.

2.1.2 Broad-Band Operation

The Trunked *Mostar* Radio can operate over the entire 800 MHz frequency spectrum. Since frequencies can be added or changed without retuning or realigning the radio, the unit can operate in different systems on widely separated frequencies.

2.1.3 Frequency Synthesis

Specific radio frequencies are generated electronically by using frequency synthesis, rather than individual crystal circuits or channel elements. This simplifies multiple-frequency operation since frequencies can be changed or added by plugging in a different code plug.

2.1.4 Improved Transmitter and Receiver Performance

The Trunked *Mostar* transmitter provides audio distortion rated at less than 3% (at 1000 Hz, 60% maximum deviation) and a frequency stability of ±.00025% of assigned center frequency (over an ambient temperature range from −30°C to +60°C). Spurious and harmonic emissions are rated at greater than 56 dB below carrier. Sensitivity of the receiver is rated at .30 microvolts (EIA SINAD), and spurious and image rejection is −80 dB. Frequency stability is identical to that of the transmitter.

2.1.5 Programmable Time-Out-Timer

The code plug can be programmed to cause the transmitter to cease transmission at timer lengths of 15, 30, or 60 seconds.

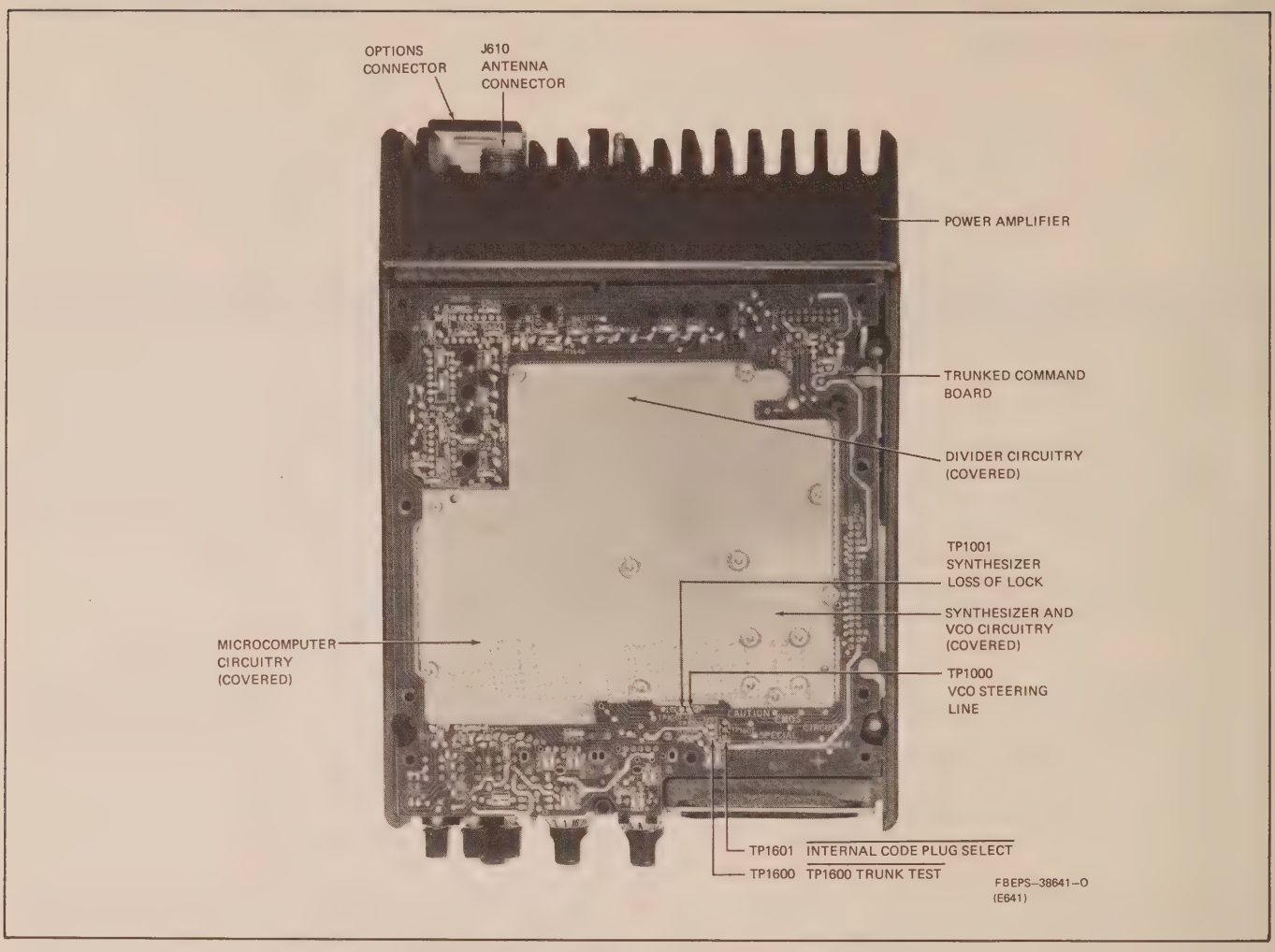

Figure 1. Top View of Trunked Mostar FM Two-Way Radio

2.2 OPTIONAL FEATURES

The Trunked *Mostar* Radio may include some of the following optional features. These and other options are described in detail in the Operating Instruction section of this manual.

- Subfleet Select
- Multiple System Select
- Multiple *Call Alert* Encode
- Multiple *Private Conversation* Capability with Multiple *Call Alert* Encode
- Public Address
- Telephone Interconnect Interface
- Control Station

2.2.1 Subfleet Select

This option allows the operator to communicate with one of up to eight subfleets or up to seven subfleets with fleet wide calling capability. Refer to Figure 5 in this section.

2.2.2 Multiple System Select

This option allows the operator to select up to three or six different systems depending on the option ordered.

2.2.3 Multiple *Call Alert* Encode

This option allows the operator to page up to eight individual radios, one at a time, and activate an external alarm.

2.2.4 Multiple *Private Conversation* Capability with Multiple *Call Alert* Encode

This option allows the Trunked *Mostar* Radio the capability of handling up to eight *Private Conversation* calls per fleet. The radio can also page up to eight individuals (the eight individuals must have the same code).

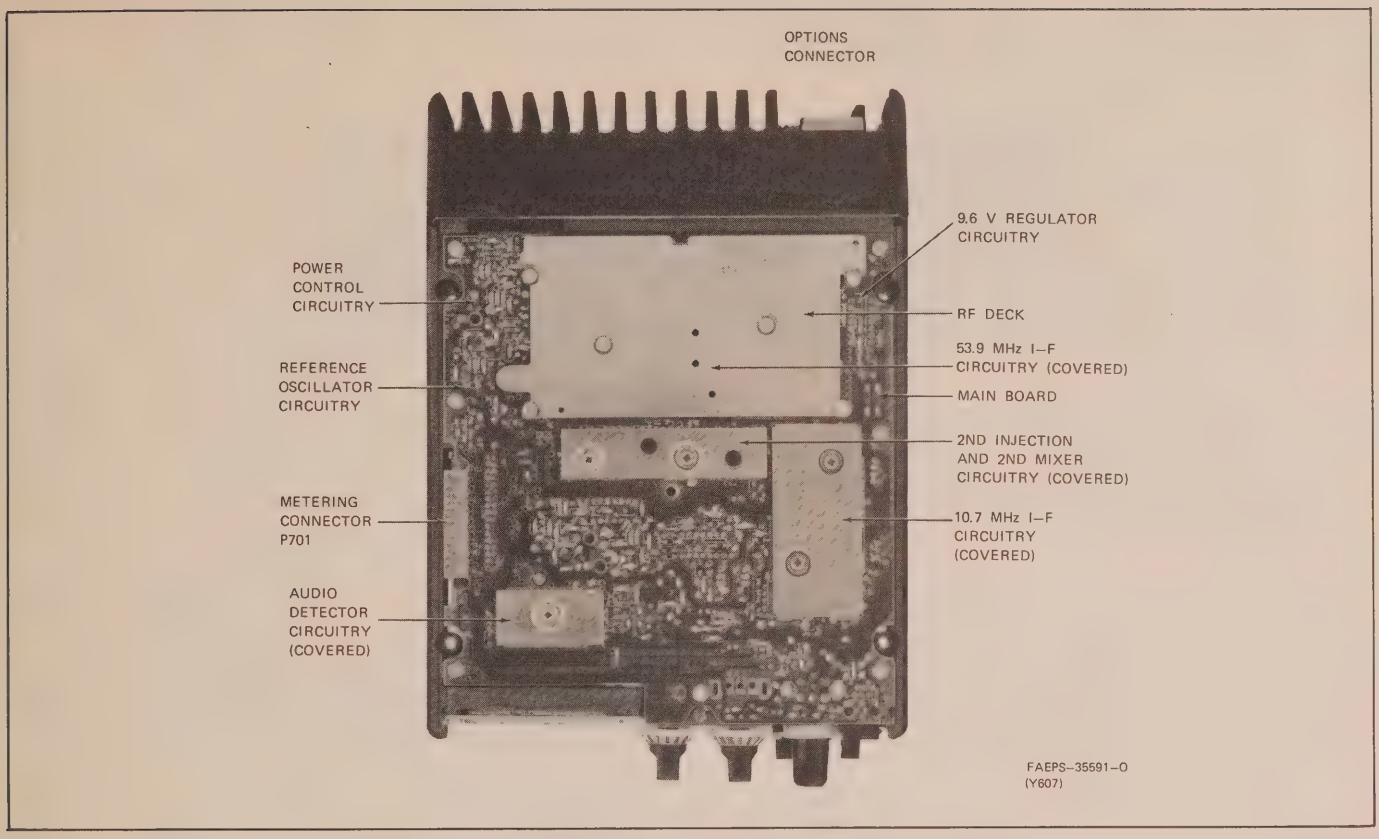

Figure 2. Bottom View of Trunked Mostar FM Two-Way Radio

2.2.5 Public Address

This option allows the Trunked *Mostar* Radio to act as a public address vehicle. Received messages and transmissions can be heard outside of the vehicle by means of an external speaker.

2.2.6 Telephone Interconnect

This option allows the Trunked *Mostar* Radio to act as a simplex telephone utilizing a special *Touch-Code* encoder microphone and phone patch.

2.2.7 Control Station

This option allows the Trunked *Mostar* Mobile Radio to be used as a control station. The control station package provides a Trunked *Mostar* Radio, desk microphone, base power supply, and appropriate cables.

3. ELECTRICAL CHARACTERISTICS

The Trunked *Mostar* Radio, package model, comes fully equipped for 20-channel operation. The unit operates from a negative-ground, 12-volt dc source. An internal speaker, microphone, gain antenna with a 14-foot cable, a 10-foot negative-ground cable kit, and a locking trunnion are included.

3.1 CIRCUIT BLOCKS

The Trunked *Mostar* Radio contains three circuit boards: (a) trunked command board, (b) main board, and (c) 15-watt power amplifier board.

3.2 FUNCTIONAL DESCRIPTION

The Trunked *Mostar* Radio can be functionally divided into four parts: (a) microcomputer, (b) frequency synthesizer, (c) receiver, and (d) transmitter. The microcomputer circuits and the frequency synthesizer circuits are contained on the trunked command board. The receiver circuits are contained on the main circuit board. The transmitter circuits are contained on both the main circuit board and power amplifier board. A brief description of each functional segment is provided below. Further description is provided in the Theory of Operation section in this manual.

3.2.1 Microcomputer
(Refer to Figure 3)

The trunked command board contains the microcomputer system. The microcomputer consists of a Motorola MC6805U3 8-bit microprocessor system which has a read only memory that contains the operating program, a code plug, and associated sup-

porting and control circuitry. The microcomputer controls all operations of the trunked radio from lighting the control panel indicators to frequency selection.

3.2.2 Frequency Synthesis

The frequency synthesizer is used to generate the first receiver injection frequency and transmitter carrier frequency. The synthesizer employs a 400 MHz phase-locked loop (PLL) that consists of:

- a 14.4 MHz reference oscillator
- a low-noise voltage controlled oscillator (VCO)
- a high-speed ÷ 127/128 variable modulus prescaler
- a fully programmable CMOS synthesizer integrated circuit with a digital phase detector
- a loop filter.

A doubler/buffer/T-R switch located on the main circuit board doubles the VCO 400 MHz output frequency for use by the radio (the 14.4 MHz reference oscillator is also applied via an injection tripler to the second mixer of the receiver.) Transmit audio is applied to both the VCO and reference oscillator modulation ports.

3.2.3 Receiver

The incoming rf signals are applied to the rf preamplifier via the antenna switch and a 2-cell preselector filter. The preamplifier output passes through a 4-cell preselector filter and is then applied to the first mixer stage. The selectivity of the two filters prevents high-level, out-of-band signals from degrading receiver performance. The frequency synthesizer rf output is doubled and then applied to the first mixer via a 3-cell injection filter. The first mixer generates an i-f (intermediate frequency) of 53.9 MHz that is sufficiently amplified to drive the second mixer. The second mixer uses the 53.9 MHz signal and a 43.2 MHz signal from an injection tripler to generate a 10.7 MHz i-f. After amplification, the 10.7 MHz signal passes to the limiter/detector stage. The receiver uses two 4-pole crystal filters that substantially attenuate signals outside the predetermined receiver bandpass range. The detected audio is fed to audio amplifiers on the main circuit board. When the microcomputer enables the audio gate, the audio is amplified and applied to the speaker.

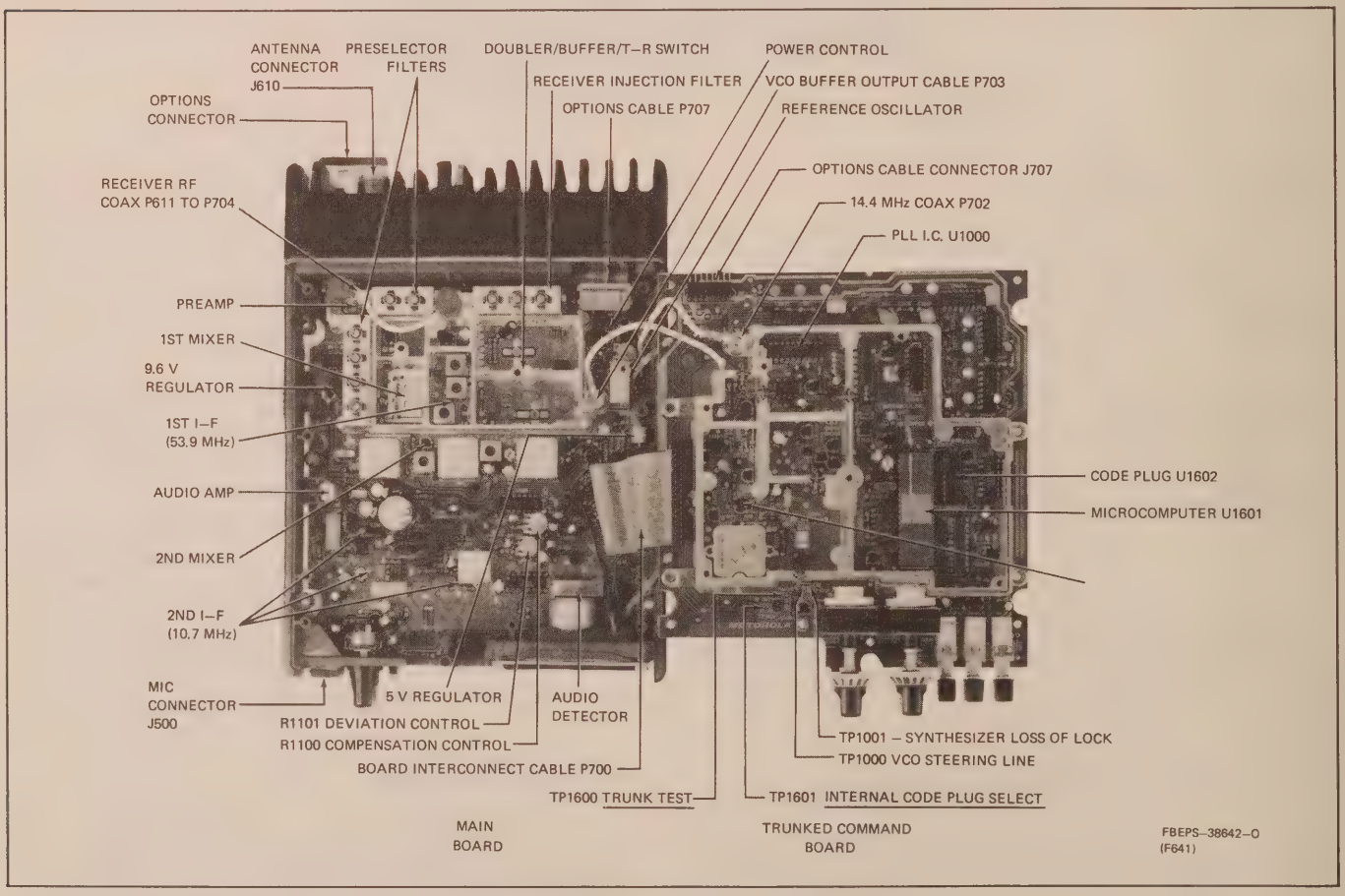

Figure 3. Top View of Mostar Trunked FM Two-Way Radio with Main Board and Trunked Command Board Exposed (shields removed)

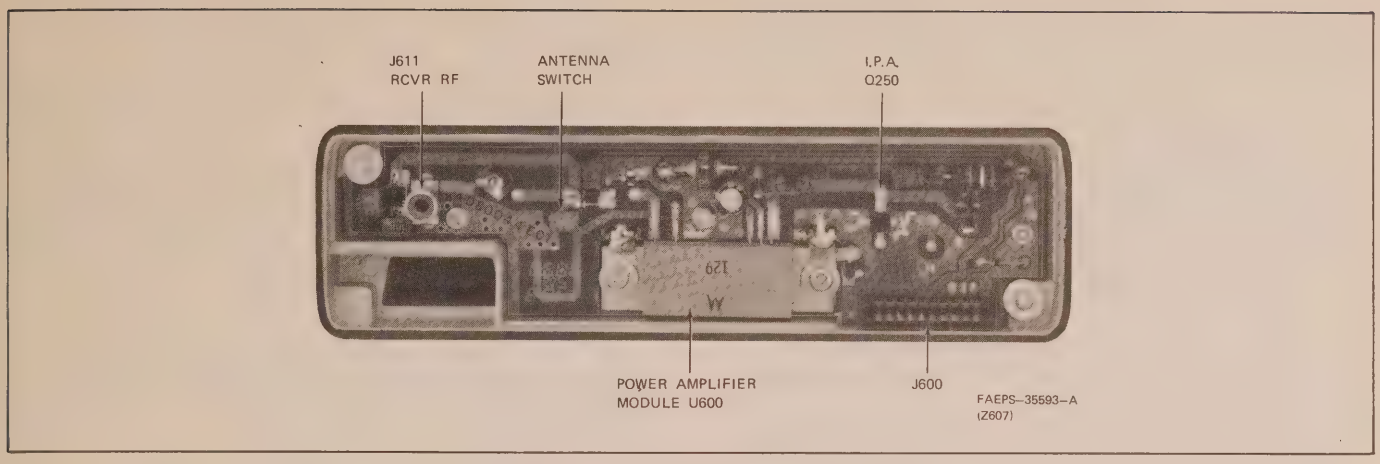

Figure 4. Power Amplifier Detail (shield removed)

3.2.4 Transmitter

The rf output generated by the frequency synthesizer at the required transmit frequency is applied to the doubler/buffer circuit. The rf signal from the doubler/buffer diode switch is then applied to the Intermediate Power Amplifer (IPA) via connector, J600-1,3. The rf signal passes from the IPA to the power amplifier module, and is applied to the antenna connector via the antenna switch. The PA module consists of three distinct amplifier stages mounted on a substrate. The first stage is controlled like the IPA and drives the final two stages. The transmitter is provided with a temperature-sensing circuit that works in conjunction with the power control circuit located on the main circuit board. The power control circuits provide final current leveling and protection to the final power amplifier stage of the transmitter. These circuits sense final current from the last stage of the PA module, providing a means of power control. The transmitter IPA receives a control voltage that is determined by the final current, and final PA temperature data. When the control voltage changes, it causes a change in the rf drive level to the final PA module stages.

4. PRIMARY POWER SOURCE

The Trunked *Mostar* Radio operates from a negative-ground, 12-volt dc source.

5. PHYSICAL CHARACTERISTICS

The Trunked *Mostar* Radio electronic circuits are enclosed in a rugged low-profile housing. The power, antenna, and options cable connectors are located at the rear of the radio on the power amplifier heat sink which provides cooling for the power amplifier circuits. The various radio circuits are provided with proper isolation by using partitions and shielding covers. The radio employs an easy-to-remove top and bottom cover that is secured to the radio by means of four screws, which allows access to all metering and adjustment locations.

CAUTION

Do NOT remove cover while radio is keyed.

6. TRUNKED RADIO SYSTEM DESCRIPTION

The information provided in the following paragraphs describes the basic system functions of the equipment used in a Motorola Trunked Radio System. It is meant only to provide an overall system description. The description is presented so that the mobile radio system portion described in this manual is more completely understood.

6.1 TRUNKED RADIO SYSTEM BENEFITS

Communication "trunking" improves operating efficiencies by sharing system resources among the users. Trunking techniques are well established in the communcations industry and are used by telephone companies to support the millions of calls they service. Motorola has adapted similar trunking methods to the two-way radio industry.

A trunked radio system allows a large number of users to share a relatively few number of frequencies. When a mobile operator wishes to establish communications with someone else in the system, a repeater, or communications path is assigned to that operator. Once the conversation has ended, the repeater is freed for other users. This sharing of frequencies is accomplished automatically in a Motorola Trunked Radio System through the use of multiple repeaters and a central controller. Trunking allows all of the repeater air time to be simultaneously pooled, maximizing the amount of air time available to any one mobile unit and minimizing channel congestion.

Some of the key benefits of the Motorola Trunked Radio System are:

- No channel monitoring required prior to transmission
- Fast system access
- Automatic channel selection
- Privacy among members of the same group
- Uninterrupted conversations

6.2 TRUNKED RADIO SYSTEM EQUIPMENT

The Motorola Trunked Radio System operates in the 800 MHz frequency spectrum. The system employs the following equipment:

- central controller
- base repeater stations (as required)
- RF control station (as required)
- mobile radio units (as required)

The microprocessor-base central controller directs the operation of the Motorola Trunked Radio System and is responsible for managing the flow of communications among the Motorola Trunked Radio System users. This includes processing of call requests, gathering of statistical data, and providing status and alarm reports.

6.3 TRUNKED RADIO SYSTEM FEATURES

The Motorola Trunked Radio System provides a variety of features, many of which are not available in conventional systems. These features can be broken down into the following major catergories:

- system manager capabilities
- system user call capabilities
- system reliability capabilities
- system access features
- system expansion features

7. SYSTEM MANAGER CAPABILITIES

7.1 CHANNEL CAPABILITY

FCC Docket No. 18262 stipulates that users or system operators needing six or more channels in the 800 MHz spectrum are required to operate trunked systems. Moreover, trunked systems from a minimum of five channels to a maximum of twenty channels are authorized. The basic Motorola Trunked Radio System consists of twenty channels and is able to fulfill fewer channel requirements via "delete" channel options.

7.2 CO-LOCATED BASE END EQUIPMENT

A typical five-channel Motorola Trunked Radio System is a single site system, thus requiring that the five repeater stations and the central controller can be located at one site. The central controller can be located a maximum distance of 100 cable feet from the base repeaters. With such an arrangement, all servicing and operating functions can be carried out at the site.

7.3 SYSTEM CONTROL TERMINAL INTERFACE

The central controller provides an RS-232-C interface that allows the connection of an optional keyboard terminal to the system. The terminal provides the system manager with a higher level of system control. The terminal can be used to:

- provide reports on equipment status and alarms
- selectively enable or disable individual channels
- adjust system time-out parameters

8. SYSTEM USER CALL CAPABILITIES

8.1 SUBFLEET CALL

The subfleet call is the basic element that is served by the Trunked Radio System. Also, the subfleet call is the standard call capability. A subfleet call allows all member subfleet radio units to monitor and initiate transmissions within that subfleet only. This provides the effect of a private channel on the subfleet level.

8.2 FLEET CALL (OPTIONAL)

This option allows the user of a Motorola Trunked Radio System to simultaneously initiate communications with all members of the fleet, without regard to subfleet boundaries. The central controller monitors any subfleet all made within the fleet on a FIFO (first-in-first-out) basis. Fleet privacy is assured, since no two fleets would ever be assigned the same voice channel at the same time. This makes it impossible for any member radio unit of one fleet to interfere with members of another fleet. This eliminates the need to monitor other users before starting transmissions. (See Figure 5 for a typical fleet/subfleet configuration.)

An optional selector switch allows mobile radio units of the same fleet to selectively move between subfleets within the fleet. Moreover, dispatchers (rf control stations) and selected mobile radios can be given both fleet call and subfleet call capabilities by means of a single selector switch. Fleet call, in a subdivided fleet, allows the dispatcher or selected mobile operator to transmit a message to all member radio units in his fleet, without regard to subfleet boundaries.

The subfleet call and fleet call selections are made via a single selector switch. The system-wide call is made via a separate, selector switch. The basic rf control station can be programmed either to operate within a specified subfleet or be given in fleet call capability. With this latter capability, its transmissions would be heard in all subfleets, and its receiver would monitor activity in all subfleets, on a FIFO basis.

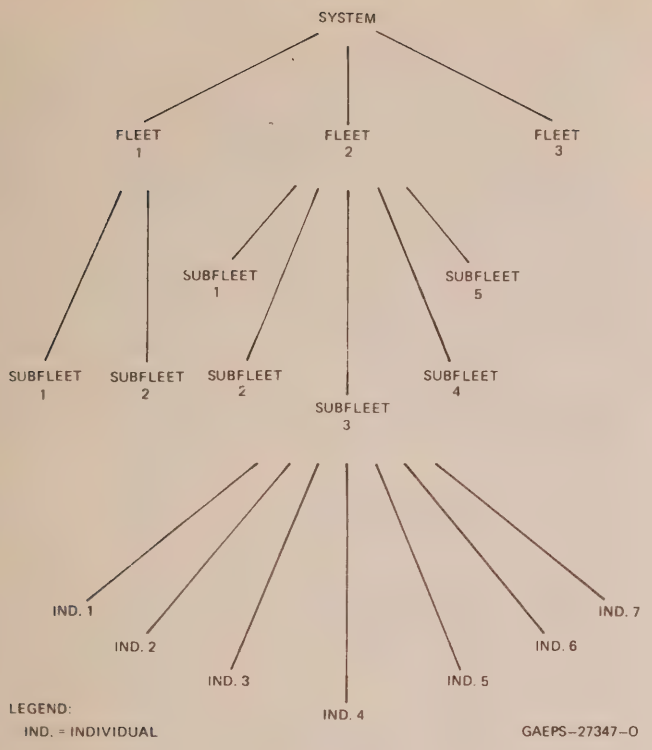

Figure 5. Typical Fleet/Subfleet Configuration

An rf control station, equipped for multiple subfleet operation, receives only one subfleet at a time. Consequently, if the dispatcher sets the selector switch to one subfleet, he will not receive calls originating in a different subfleet. The same holds true for fleet call operations. If there is simultaneous operation in different subfleets, an rf control station placed in the fleet-call mode will receive only one subfleet, since the rf control station receives the subfleets on a FIFO basis. Multiple rf control stations allow the dispatcher to monitor calls in more than one subfleet simultaneously.

9. SYSTEM RELIABILITY CAPABILITIES

9.1 MULTIPLE CHANNELS

The multiple channel aspect of the Motorola Trunked Radio System provides a high degree of system reliability. Motorola Trunked Radio System channels are assigned by the central controller as needed. No user is dependent on any given channel for his communications. A failure of any one channel, in a Motorola Trunked Radio System, will probably not be apparent.

If a channel fails, the central controller is programmed to assign only the working channels. Only during busiest use periods would the users of the Motorola Trunked Radio System notice heavier-than-normal channel holding times and longer-than-normal user access times caused by the loss of a channel.

9.2 BACK-UP CONTROL CHANNELS

The failure of an individual channel would not (in most cases) lead to a degradation of system performance. If the control channel fails, however, the whole system could go off the air. To prevent this, the central controller is programmed to assign one of the voice channels as a substitute control channel. Under such conditions, the mobile units will recognize the new control channel and system operation will proceed without interruption.

9.3 RECEIVER INTERFERENCE

A Trunked Radio System base repeater may be jammed by the receipt of an unauthorized signal. The central controller is programmed to turn off the repeater whenever it detects a carrier on a channel that has not been assigned to members of the system. The repeater will be reassigned only when the unwanted carrier is removed.

9.4 TRANSMITTER FAILURE

The central controller is programmed to detect any loss of reduction in the output power of any of the repeater transmitters. When the transmitter output power falls below a certain level, the channel will be automatically taken out of service.

9.5 SYSTEM SELF-DIAGNOSTICS

The system self-diagnostics comprise central controller integrity, repeater receiver interface checks, and repeater transmitter interface checks. The detection of a fault can trigger visual and/or audible alarms at the controller site. Relays are used for implementing these alarm functions.

9.6 FAILSOFT

A failsoft feature has been incorporated into the system to insure continued communications if the system central controller should develop a fault. When the central controller becomes inoperative, the mobile units will automatically revert to their preassigned failsoft channels (system voice channels) and will be capable of conventional repeater operation on these channels. Once in the failsoft mode, however, the system will lose most of its fleet and subfleet privacy, but this privacy will be resumed as soon as normal system operation is restored.

A subaudible data handshake is activated on each voice channel whenever the repeaters go into failsoft mode. This will insure that the mobile units will not operate in the failsoft mode simply because they went out of range of the central. Thus the mobile units will remain operative as long as they receive the subaudible data.

Since failsoft channel assignments are a function of the mobile unit code plug, they must be specified at the time of code programming. These assigments are made such that all the system mobile units are evenly distributed over the system voice channels. Members of the same fleet or subfleet should be assigned to the same channel. Mobile Units can be denied failsoft operation.

10. SYSTEM ACCESS FEATURES

10.1 TALK PROHIBIT TONES

There will be times when all the channels in the Trunked Radio System are busy. Since it is not possible to monitor other users on a trunked system, mobile operators will be provided with talk-prohibit tones. Any user depressing his PTT pushbutton while the system channels are busy will receive a talk-prohibit tone. This tone is similar to a telephone-type busy tone. A constant sounding tone is provided whenever the mobile operator cannot access the system because of the following reasons:

- the mobile unit is out of range
- the system is out of service

10.2 CALL LIGHT (OPTIONAL)

This feature operates in one or both of the following ways depending on the options programmed in the radio code plug. With *Call Alert*, the light will flash indicating that the mobile has received a call message from the dispatcher or another mobile. With *Private Conversation* call, the Call Light will flash at the receiving mobile when another unit is requesting a private conversation. When depressing the Private Mode pushbutton to receive or send a *Private Conversation* call the Call Light will light continuously.

10.3 BUSY QUEUE/CALL BACK

Users requesting system access at a time when all voice channels are in use will be put in a waiting queue and will be served on a FIFO basis. When a channel becomes free, the central controller will send a call back tone to the first mobile unit in the waiting queue. The call back consists of a short series of beeping tones which can be heard by the mobile operator. This feature permits the operator who receives a busy indication to set down his microphone and wait for the call back signal rather than keep on depressing his PTT pushbutton in an attempt to access a system channel. These features operate only when the mobile unit is within range.

10.4 TALK-PERMIT TONE (OPTIONAL)

This feature provides a mobile operator with a brief (200 ms) series of tones whenever he keys up a voice channel. The talk-permit tones, which are identical to the call back tones, provide the operator with an indication that he has keyed up on a voice channel. Since this feature is a code-plug-implementable option, it can be provided on a select number of mobile units as desired.

10.5 AUTOMATIC RETRY

A channel request is initiated by depressing the PTT pushbutton and causing the transmitter to send a burst of data to the central controller via the control channel. Since a single burst of data may not get through because of adverse signaling conditions or interference, the radio unit is designed to keep on sending channel request — until a request acknowledgement is received from the central controller or until four seconds have elasped. These attempts will continue even if the operator releases his PTT switch. Thus, the operator is not required to continually depress his PTT pushbutton in an attempt to gain access to the system.

10.6 RECENT USER PRIORITY

This feature provides users who have been assigned voice channels with priority over other system users, thus insuring that a fleet engaged in a message transmission will get system access priority even if there is a significant delay between transmissions. This reduces the possibility of a channel not becoming available during an exchange of transmissions if a mobile operator is slow in responding.

10.7 MISDIRECTED MOBILE PROTECTION

To insure that no mobile unit from one fleet will accidentally be assigned to a voice channel used by a different fleet, a subaudible data handshake is implemented in the system. Once a fleet is assigned to a voice channel, the repeater of the assigned channel will keep on sending an outbound stream of subaudible data

containing the unique fleet or subfleet ID of the units using the channel. Should a unit from a different fleet or subfleet be accidentally assigned to the same channel, the unit would automatically revert to the control channel since it does not have the proper ID. The audio of the erring mobile unit would be muted and the transmitter disabled for the fraction of a second that is actually spent on the wrong channel and thus could neither monitor nor key on the wrong channel.

10.8 CONTINUOUS ASSIGNMENT UPDATING

Once a voice channel is assigned to a fleet or subfleet, the control channel will keep on transmitting the channel assignment for as long as that fleet is using the channel. This insures that a mobile just coming into service will be sent over to the appropriate channel to join the rest of his fleet. The assignment updating information will be sent serially, and the total time that will be required by the control channel to run through 19 assignments on a 20-channel system is approximately 500 milliseconds.

11. SYSTEM EXPANSION FEATURES

11.1 ORDERLY SYSTEM EXPANSION

The Motorola Trunked Radio System is structured such that it allows the addition of mobile units without affecting the operation and privacy of mobile units currently using the system. Mobile units can be added to an existing user fleet or new users can be added without the need for any system changes — within the capacity limitations of the system.

To increase the number of channels in a Motorola Trunked Radio System, all that need be done is to add the necessary base repeater station and central controller equipment. It is not necessary to modify any trunked mobile radio or rf control station to add an additional channel. The trunked mobile radio and rf control station will automatically accommodate the added voice channel.

11.2 COMMONNESS OF RF EQUIPMENT

All the mobile rf equipment in a Trunked Radio System will be identical in rf capability — with the exception of options that may vary from one mobile unit to another. This facilitates servicing of equipment and reduces spare parts inventory.

12. SYSTEM SIGNALING

Effective system operation has been achieved by binding the individual system blocks into a highly efficient coordinated entity by means of the data communications network. The majority of the data communications operations occur over the system control channel. For example, requests for service are transferred from the system users to the central controller over this channel. Similarly, the control channel is used by the central controller to transfer channel assignment data or other control commands to the users.

All communications over the control channel employ data words which are approximately 23 milliseconds long. These data words contain the information capacity required to address particular mobile units or groups and to specify the action to be taken. The information bits comprising these words are appropriately assembled into a coded format that has sufficient error-correction and detection capabilities to assure that highly reliable data communications will be maintained in a two-way mobile radio environment. The encoded binary data is passed to the transmitter at a 3600 baud rate where it is filtered and impressed on the carrier by using direct baseband frequency modulation.

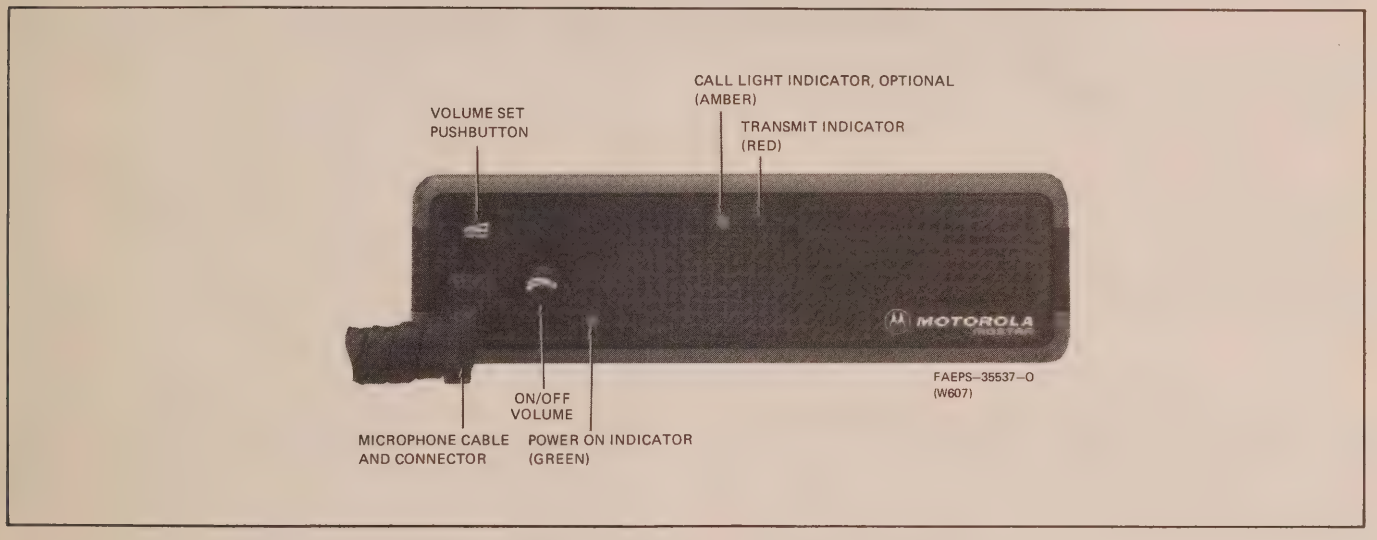

Figure 1. Basic Operating Controls and Indicators

1. GENERAL

The *Mostar* trunked mobile equipment consists of:

- dash mount fm two-way trunked mobile radio
- palm microphone
- gain antenna
- interconnecting power cable
- internal speaker
- locking mounting trunnion

The *Mostar* trunked control station equipment (optional) consists of:

- fm two-way trunked control station radio
- desk microphone
- base station power supply
- interconnecting power cable
- internal speaker

2. BASIC OPERATION

2.1 INTRODUCTION

Before operating either the trunked mobile or control station radio, the operator should be familiar with the various operating controls, indicators and status tones. Operation of the mobile and control station radio is identical.

2.1.1 Controls and Indicators

A *Mostar* mobile or control station radio can be provided with either a basic control configuration, or be equipped with various option switches for different modes of operation.

The standard control configuration (see Figure 1) consists of the following controls and indicator lights:

- ON/OFF VOLUME
- VOLUME SET pushbutton
- power on indicator (green)
- transmit indicator (red)
- Call light (amber, optional)

2.1.2 Optional Controls and Indicators

The control configuration of a *Mostar* mobile or control station radio utilizing some of the different optional features is shown in Figure 2.

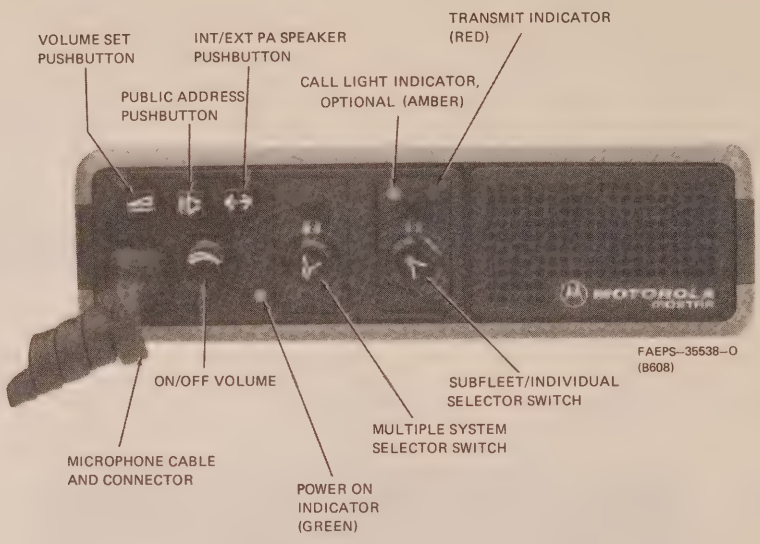

Figure 2. Optional Operating Controls and Indicators

Operation of some *Mostar* radio optional features is described in the following pages.

2.1.3 Alert Tones

The following alert tones aid the operator by indicating unique system conditions.

- **Volume Set** — Continuous tone, heard when Volume Set pushbutton is depressed so speaker volume can be set.
- **Call back** — Three short high pitched tone bursts, heard following a **System Busy** tone, indicating that a channel is now available for the previously requested transmission.
- **Talk Prohibit** — Continuous low pitched tone, heard only while PTT is depressed, indicating that either the mobile radio is out of range of the trunked radio system, or that the system is out of service.
- **System Busy** — Telephone type busy signal. If heard upon depressing PTT button, indicates that the call has been accepted by the system, but all channels are currently in use or a fleetwide call is pending. The System Busy tone is followed by the Call Back tone when a channel becomes available.
- **Failsoft (optional)** — Short tone burst, heard every 10 seconds in an unmuted receive mode, indicates failure of the System Central Controller. The radio reverts from trunked operation to an operation similar to that of conventional repeater system but without squelch control.
- **Time-Out Timer (T.O.T.)** — Continuous low pitched tone heard while transmitting, 4.8 seconds before the transmitter times out.
- **Talk Permit (optional)** — Three short high pitched tone bursts, (same sound as Call Back) heard upon depressing PTT button, which verifies that the system is accepting the transmission.
- **Telephone Interconnect Busy (optional)** — Four telephone type busy tones indicating interconnect repeater is busy when telephone pushbutton is depressed. Will be followed automatically by Call Back tones when interconnect repeater becomes available, as long as the operator remains in the telephone interconnect mode.
- ***Private Conversation* (optional)** — Two high pitched tone bursts indicating a private call has been received.
- *Call Alert* **(optional)** — Four high pitched tone bursts indicating a *Call Alert* has been received.

2.2 OPERATING PROCEDURE

2.2.1 To Turn On Radio

Rotate the ON/OFF VOLUME control clockwise until a click is heard and the green POWER ON indicator turns on.

2.2.2 To Set Volume For Receiving Calls

- Depress the VOLUME SET pushbutton and a continuous audible tone will be heard in the speaker.

- Adjust the ON/OFF VOLUME control for the desired listening level.
- Release VOLUME SET pushbutton. Radio is now ready to receive calls.

If your radio includes more than one mode of operation, the additional calls which may be received in a particular mode, are indicated in the following table.

Table 1. Mode of Operation/Received Calls

Mode of Operation	Additional Calls Which Can Be Received (Note 3)
Subfleet Mode (Subfleet selector switch set to a subfleet position)	*Private Conversation* Calls (note 1) *Call Alert* Calls (note 2) Fleetwide Calls Systemwide Calls
Fleetwide Mode (Subfleet selector switch set to a fleetwide call position)	All Subfleet Calls *Private Conversation* calls (note 1) *Call Alert* Calls (note 2) Fleetwide Calls Systemwide Calls
Private Conversation Mode *(Private Conversation* Pushbutton Depressed)	Fleetwide Calls System Calls
Call Alert Encode Mode (Subfleet selector switch set to a *Call Alert* Position)	Fleetwide Calls System Calls
Telephone Interconnect Mode (Telephone Interconnect Pushbutton Depressed)	System Calls

(1) The Dispatcher/Supervisor units can receive all *Private Conversation* calls; Single *Private Conversation* call units can only receive *Private Conversation* calls with their same ID.

(2) Only the mobile unit with the matching transmitted ID can receive the *Call Alert* page.

(3) Fleetwide and system calls will not interrupt voice traffic, however, when a voice channel is lost, a new voice channel will not be reassigned until the Fleetwide or System Call is serviced.

2.2.3 To Transmit

- (Optional) Select the desired group with the proper subfleet selector switch.
- Lift microphone off-hook. Press and hold the PTT button.
- When the red transmit indicator lights, hold the microphone about 2 inches from your lips, speak slowly into the microphone in a normal voice, state your FCC call sign, and proceed with your message. Release PTT button to receive.
- If you hear a telephone-type busy signal, all channels are in use. Release the PTT button and wait for the Call Back tone.
- If you hear a continuous tone, you are out of range of the system. The red transmit indicator may flash several times as the radio trys to access the system. Release the PTT button and try again when the vehicle is driven within range of the system.

3. OPERATION WITH SPECIFIC OPTIONS

3.1 MULTIPLE SUBFLEET AND MULTIPLE SYSTEM OPTIONS

3.1.1 The Multiple Subfleet option allows the fleet owner to configure the units in the fleet into non-interfering conversation groups (subfleets). Subfleet select allows the operator to communicate with members of a desired subfleet within the fleet. Up to 8 subfleets (or 7 subfleets and fleetwide call) can be programmed in the radio. The 8 subfleets are identified A thru H on the Subfleet Selector switch which is also illuminated for easy viewing at night.

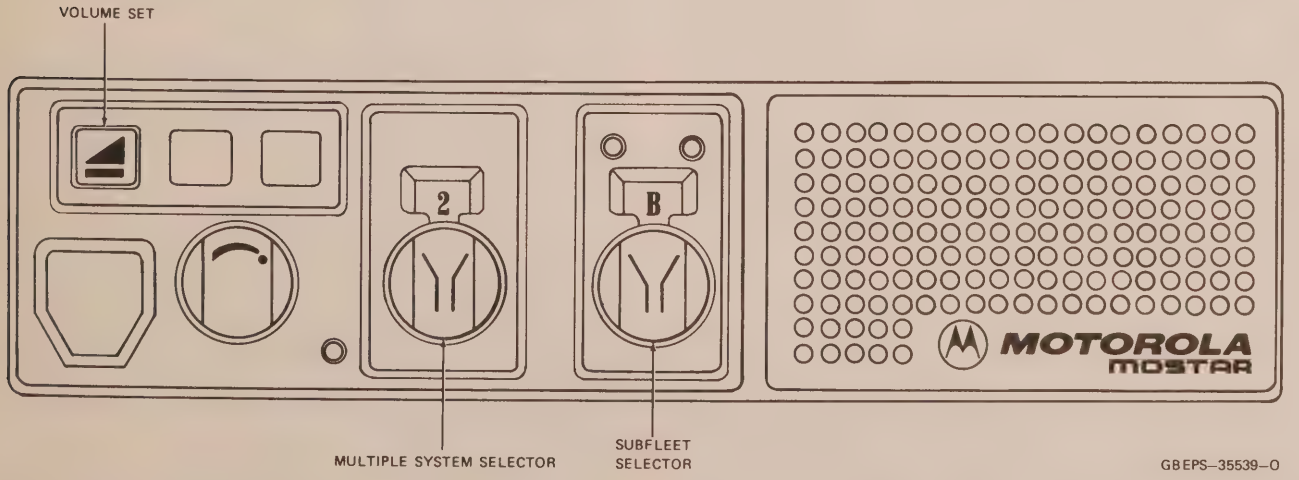

Figure 3. Mostar Radio With Either Multiple Subfleet or Multiple System Options or Both

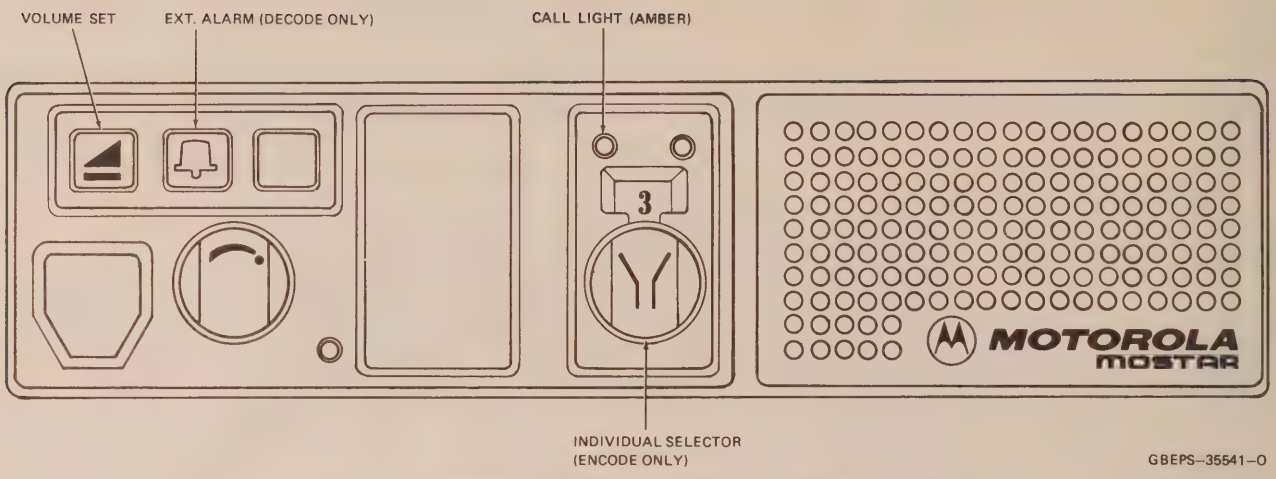

Figure 4. Mostar Radio with Multiple Call Alert Encode or Call Alert Decode Options

To operate the radio with this option, first select the desired subfleet (A-H) by rotating the Subfleet Selector switch in a clockwise direction and depress the mic PTT button to communicate with the subfleet. The radio only receives messages intended for the subfleet selected on the radio front panel, (i.e. if the radio Subfleet Selector is in position A, you will not receive subfleet B messages). Fleetwide and systemwide messages are heard regardless of the Subfleet Selector position. *Private Conversation* calls and *Call Alert* calls (with proper mobile ID) will also be heard. If less than 8 subfleets are desired, a mechanical "stop" is factory installed in the Subfleet Selector switch after the last subfleet ordered.

3.1.2 There are two Multiple System Select options: 3 Multiple System Select or 6 Multiple System Select. A mechanical "stop" is factory installed in the multiple system selector switch after the last system ordered.

To operate the radio with this option, first select the appropriate system by rotating the Multiple System Selector switch in a clockwise direction. There is a delay of approximately one second before the mobile can receive or transmit calls after a system selection is made. Once the desired system is enabled, the optional Subfleet Selector switch is used to access a particular subfleet within the selected system. Each system can have its own unique set of subfleets, *Call Alert* paging and, *Private Conversation* calls.

3.2 MULTIPLE *CALL ALERT* ENCODE OR *CALL ALERT* DECODE OPTIONS

3.2.1 The Multiple *Call Alert* Encode option allows the operator of a dispatcher/supervisor unit to selectively alert up to eight individuals (one at a time), by using the Individual Selector switch. To select the individual that is to be alerted (1-8), rotate the Individual Selector switch in a counterclockwise direction.

NOTE

The Individual Selector switch is used with Multiple *Call Alert* encode only, and also is used as a Subfleet Selector switch (clockwise rotation).

To initiate a *Call Alert* page, first select the individual (1-8) that is to be alerted (paged). Depress the microphone PTT button momentarily and then release it. The Call light flashes indicating that a *Call Alert* (page) has been transmitted. The Call light will automatically turn off, acknowledging that the page has been received by the selected individual. If the Call light doesn't turn off within 3-5 seconds after the page has been transmitted, the receiving unit did not receive the page. Try again.

The receiving unit may not have received the page for one of the following reasons:

- Unit turned off
- Unit engaged in conversation on voice channel
- Unit is out of range

After the *Call Alert* page has been transmitted, return the radio to the proper subfleet position.

3.2.2 The *Call Alert* decode option allows a mobile unit in the system to receive a *Call Alert* (page) from the dispatcher/supervisor unit. When the *Call Alert* (page) is received by the mobile unit, its Call light turns on and flashes, and an alert tone is heard. The Call light will remain flashing until the mobile operator turns the Call light off by either momentarily depressing the microphone PTT button and then releasing it, or by turning off the radio.

If the mobile unit should also be equipped with the optional External Alarm feature, the operator, before leaving the vehicle, depresses (enables) the External Alarm pushbutton so that when a *Call Alert* page is

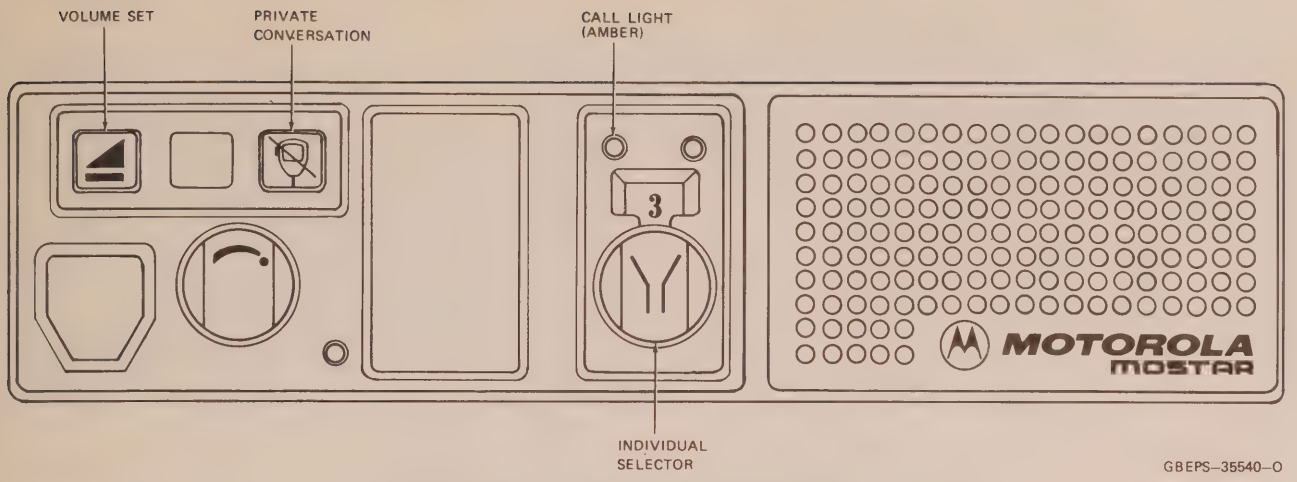

*Figure 5. **Mostar** Radio with Multiple **Private Conversation** Capability/Multiple **Call Alert** Encode*

received, it can be indicated outside of the vehicle by sounding the vehicle's horn or by turning on the headlights (if the optional control relay is installed in the vehicle).

3.3 MULTIPLE *PRIVATE CONVERSATION* CAPABILITY WITH MULTIPLE *CALL ALERT* ENCODE OPTION

3.3.1 This option allows the dispatcher/supervisor unit to privately call or *Call Alert* page up to 8 individuals, one at a time. This option is the same as Multiple *Call Alert* Encode but also includes Multiple *Private Conversation* capability.

3.3.2 To initiate a *Private Converstion*, first select the individual to be called (1-8), by rotating the Individual Selector switch in a counterclockwise direction. Next, depress the *Private Conversation* pushbutton. Now, depress the microphone PTT button, pause for a second to allow the alert tone to be received at the individual unit being called, and then begin to converse with that individual stating that the conversation is to be private.

NOTE

When a *Private Conversation* call is received at the receiving unit, an alert tone sounds (two high pitched tone bursts), and the Call light flashes.

The individual receiving this call must then depress the *Private Conversation* pushbutton on his radio so the entire conversation is private. During this mode of operation the Call light at each radio remains on (steady) to indicate the radio is in the *Private Conversation* mode.

When receiving a *Private Conversation* call initiated by another mobile, the operator of the unit equipped with Multiple *Private Conversation* capability, simply depresses his *Private Conversation* pushbutton to complete the call loop.

When the *Private Conversation* is completed, both units disengage their respective pushbutton and resume normal operations.

3.4 *PRIVATE CONVERSATION* CAPABILITY OPTION

This option allows a mobile unit to send and receive private calls only with the dispatcher/supervisor unit. Operation is the same as described in paragraph 3.3.2 except that the unit equipped with this option does not include the Individual Selector switch.

3.5 PUBLIC ADDRESS OPTION

3.5.1 Basic Public Address

To announce a public address message, depress the (PA) pushbutton, then depress MIC PTT and announce the message through the external speaker. While the (PA) pushbutton is depressed, incoming radio messages are heard in the radio internal speaker.

To transmit a message (over the air), disengage (PA) pushbutton, and proceed with normal MIC PTT for voice communications.

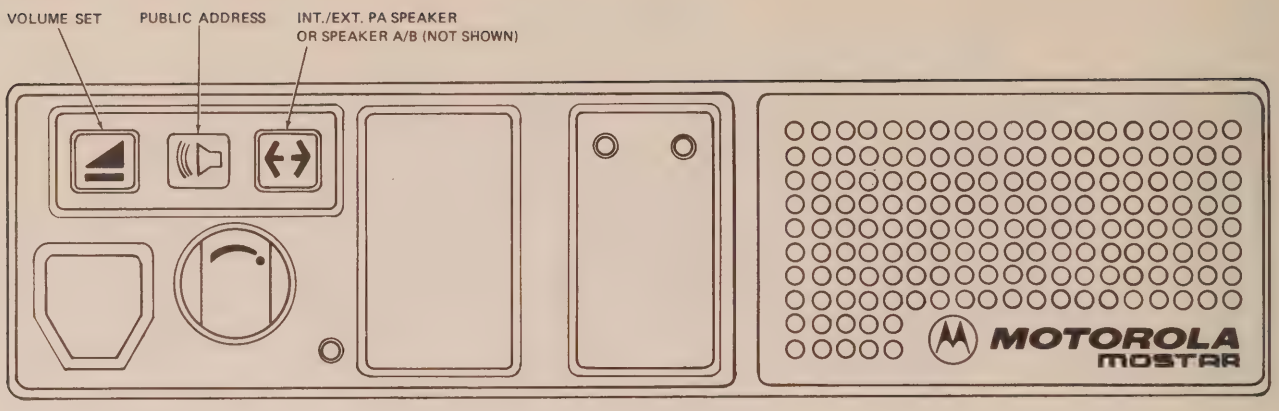

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Figure 6. Mostar Radio with Either Public Address And/Or Internal/External Speaker Options

3.5.2 Public Address with Internal/External PA Switch

To announce a public address message, first select the speaker location that you want the message to be heard from, with the Internal/External Speaker pushbutton (← →). Depress the (PA) pushbutton, then depress the MIC PTT and announce the public address message. Received audio messages are heard in the radio set internal speaker regardless of the position of the Internal/External Speaker pushbutton. Disengage the (PA) pushbutton before resuming normal MIC PTT transmission over the air.

3.5.3 Public Address with Speaker A/B Receive Audio Switch

To receive messages, first select the appropriate speaker with the A/B pushbutton. When the pushbutton is in the "out" position (A), the internal radio speaker is selected and when the pushbutton is in the "in" position (B), an external speaker is selected.

To announce a message, depress the Public Address () pushbutton, depress MIC PTT button and announce public address message. Disengage public address pushbutton before transmitting messages over the air via MIC PTT.

3.6 RECEIVE AUDIO SPEAKER SELECT OPTION

This option functions the same as the Speaker A/B Receive Audio switch option except for not being used with Public Address. When the pushbutton switch is in the "out" position, receive audio is routed to the radio internal speaker. When the pushbutton switch is in the "in" position, receive audio is routed to an external speaker at another location.

3.7 TELEPHONE INTERCONNECT OPTION

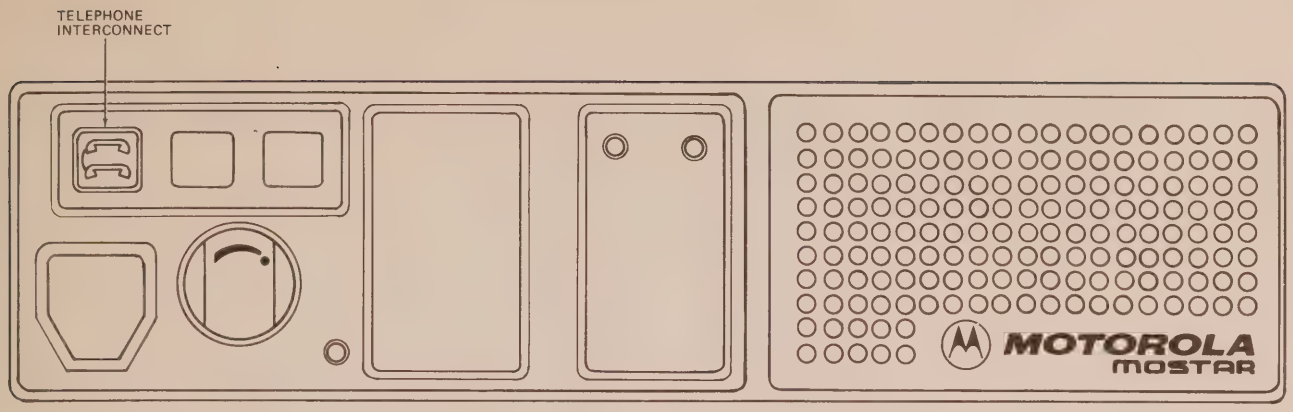
3.7.1 General

When this option is used, the normally supplied Volume Set feature is deleted. There are two types of mobile telephone interconnect: Simplex and Half Duplex. In the Simplex mode, operation is with a control station utilizing a phone patch. All mobile-initiated telephone interconnect calls are private between the mobile operator, control station operator, and the land-line party. All land-line initiated calls, however, are not private since the call will be heard over the entire subfleet.

In the Half Duplex mode, telephone interconnect functions through the system central controller and all calls between the mobile operator and land-line user are private.

3.7.2 Simplex Control Station Patch Operation

- To initiate a call, first depress the Telephone Interconnect pushbutton.
- A Talk Permit tone burst will be heard, indicating your call may begin. If the telephone interconnect channels are in use, you will hear a System Busy signal. When a channel becomes available, you will be alerted by the Automatic Call Back tone burst and you can begin your call. You will have three (3) seconds to commence entering your special access code (as follows) before the transmit indicator light goes out and the call will not be processed.
- The system owner has provided you with a special access code for this trunked system. This access code is comprised of a digit and a star such as 0* (which is commonly used). The actual call is made by entering the special access code on the *Touch-Code* encoder microphone.



GBEPS-35543-O

Figure 7. Mostar Radio with Telephone Interconnect Option

- Once the access code is entered, a dial tone will be heard. No dial tone means the control station is busy with other traffic, therefore return to subfleet mode and try placing the call later. A steady warning tone (heard when actuating the PTT button) indicates your code was not initiated within three seconds after the Talk Permit tone burst and you must re-initiate it by returning to the subfleet mode then placing your call again.

- When the dial tone ceases, enter the telephone number you wish to call on the *Touch-Code* encoder microphone.

- When your party answers, explain that only one person can talk at a time and that each time you release your PTT button they will hear a soft dual tone beep. Proceed with your conversation in normal push-to-talk manner.

- The system owner has provided you with a special disconnect code for this trunked system. This code is comprised of a digit and pound-sign such as 0# (which is commonly used). Upon completion of your call, enter the disconnect code on your *Touch-Code* encoder microphone.

- Return your radio to subfleet operation by releasing the interconnect pushbutton before placing another Telephone Interconnect call, and after the last call.

3.7.3 Half Duplex Central Controller Patch Operation

- To initiate a call, first depress the Telephone Interconnect pushbutton.

- Wait until a dial tone is heard. If the system is busy, you will hear a System Busy signal. When a channel becomes available, you will be alerted by the Automatic Call Back tone burst, and you can begin to make your call as follows.

- Using the *Touch-Code* encoder microphone, key in the desired telephone number.

- When your party answers, explain that only one person can talk at a time and that each time you release your PTT button they will hear a soft dual tone beep. Proceed with your conversation in normal push-to-talk manner.

- When the call is complete, return your radio to subfleet operation by releasing the interconnect pushbutton before placing another telephone interconnect call, and after the last call.

1. UNPACKING

When unpacking the radio from its shipping carton, refer to the model chart at the front of this manual. If any item is missing, contact your Motorola representative immediately.

2. LICENSING REQUIREMENTS

FCC regulations state that a station license must be obtained for each radio installation (mobile or base) by the owner of the equipment. The station licensee is responsible for ensuring that the transmitter power, frequency, and deviation are within the limits permitted under the station license. Adjustments to the transmitter section of the radio may be made only by a technician possessing an FCC general class, or first or second class radiotelephone operator's license. No operator's license is required to install or operate the radio.

3. SERVICE

A service contract can be purchased for Motorola equipment by contacting the local Motorola Service Representative, or write to:

National Service Manager
Motorola Communications Group
1301 E. Algonquin Road
Schaumburg, Illinois 60196

4. BENCH CHECK

4.1 INTRODUCTION

Each *Mostar* radio set is adjusted, tested, and inspected before shipment. However, it is recommended that both the transmitter and receiver sections of the radio be checked for proper operation just prior to installation.

4.2 TESTING

The radio should be tested with all cables and accessories supplied with the radio connected as they will be in the final installation. The frequency, deviation, and output power of the transmitter should be checked, as well as the sensitivity, and audio quality of the receiver. The *Mostar* radio does not have a squelch control since the squelch function is controlled by the microcomputer. Refer to the specifications page at the front of this manual to determine whether the radio is operating properly. Improper operation can generally be corrected by touching up the receiver or transmitter alignment.

5. INSTALLATION PLANNING—MOBILE RADIOS

5.1 GENERAL

Planning is the key to fast, easy radio installation. Before a hole is drilled or a wire is run, inspect the vehicle and determine how and where you intend to mount the antenna, radio set, and accessories. Plan wire and cable runs to provide maximum protection from pinching, crushing, and overheating.

5.2 RECOMMENDED TOOLS FOR INSTALLATION AND SERVICING

5.2.1 The following list of tools is recommended for proper installation and servicing of your new *Mostar* trunked radio. Most of the screws used are slotted *TORX*® pan head screws. It is recommended that during installation and when servicing is required *TORX* screw drivers be used. However, a slot is provided on the screw head for situations where a *TORX* driver is not available.

5.2.2 Recommended Installation Tools

The following tools are recommended for installation purposes:

- 1-Phillips #2 Screwdriver
- 1-*TORX* Screwdriver, T25
- 1-1/4" Hex Driver
- 1-5/32" Dia. Drill Bit
- 1-3/8" Dia. Drill Bit

5.2.3 Recommended Service Tools

The following tools are recommended for radio servicing:

- 1-*TORX* Screwdriver, T10
- 1-*TORX* Screwdriver, T15

5.3 ANTENNA MOUNTING

The best mounting location for the antenna is in the center of a large, flat conductive surface. In almost all vehicles these requirements are best satisfied by mounting the antenna at the center of the roof. Some vehicles have a large trunk lid that will provide a good antenna location. If the trunk lid is used, connect grounding straps between the trunk lid and vehicle chassis to insure that the trunk lid is at chassis ground. Refer to the instruction manual supplied with the antenna for complete installation information.

5.4 RADIO MOUNTING

5.4.1 Locking Trunnion

5.4.1.1 The Model HLN4426A Locking Trunnion consists of a two piece trunnion type mounting bracket equipped with a key lock and associated mounting screws and is designed to facilitate easy removal. The locking trunnion may be mounted on either metal or plastic surfaces, provided the mounting surface can adequately support the weight of the radio.

5.4.1.2 Although the trunnion can be mounted to a plastic dashboard, it is recommended that the mounting screws be located so they can penetrate the supporting metal frame of the dashboard. If this is not possible, use a metal backing plate (not supplied) to strengthen the installation. Allow sufficient space around the radio for free air flow for cooling. Be sure the radio is close enough to the vehicle operator to permit easy access to operating controls.

5.4.2 The Model HLN4427A Non-Locking Trunnion mount allows the radio set to be mounted to a variety of mounting surfaces. Be sure the mounting surface is able to adequately support the weight of the radio. Allow sufficient space around the radio for free air flow for cooling. Be sure the unit is close enough to the vehicle operator to permit easy access to operating controls.

6. INSTALLATION PLANNING—CONTROL STATIONS

6.1 ANTENNA SYSTEM

Selecting the antenna system for your control station depends on factors beyond the scope of this manual. Your Motorola representative can help you choose the antenna system that will best serve your particular needs.

6.2 RADIO LOCATION

Choose a location for your control station as close as possible to where the antenna cable enters the building. Be sure 117 volt, 60 Hz power is available. Make sure sufficient air can flow around the radio to permit adequate cooling.

1. INTRODUCTION

These instructions are provided here to help you plan the dc power cable installation. Do not connect the power cable to the radio set until instructed to do so.

2. HKN4120A DC POWER CABLE INSTALLATION

2.1 **This radio must be operated only in negative ground electrical systems.** Reverse polarity will not damage the radio, but the cable fuse will blow. Check the vehicle ground polarity before you begin installation to prevent wasted time and effort.

2.2 The HKN4120A DC Power Cable (10 feet) provided with the radio is of sufficient length for installation in most vehicles. A longer power cable (HKN4144A, 20 feet) is available if more cable length is required. Begin the power cable installation in the following manner:

Step 1. Determine a routing plan for the power cable with reference to where the radio is going to be mounted.

Step 2. Drill a 3/8'' access hole in the vehicle firewall at the chosen location for passing the power cable into the engine compartment.

Step 3. Install a rubber grommet with 1/4'' I.D. (not supplied) in the access hole to avoid any damage to the cable.

Step 4. From inside the vehicle feed the RED and BLACK leads (without lugs attached) through the access hole and into the engine compartment. Refer to Figure 1.

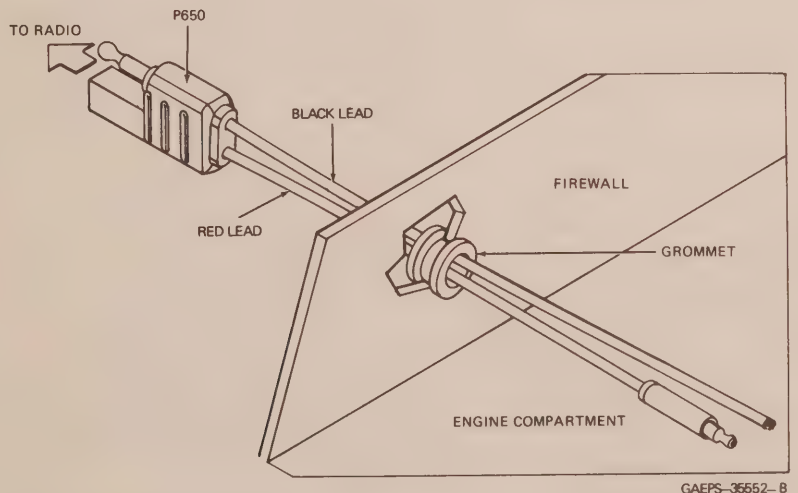


Figure 1. Power Cable Routing Into Engine Compartment

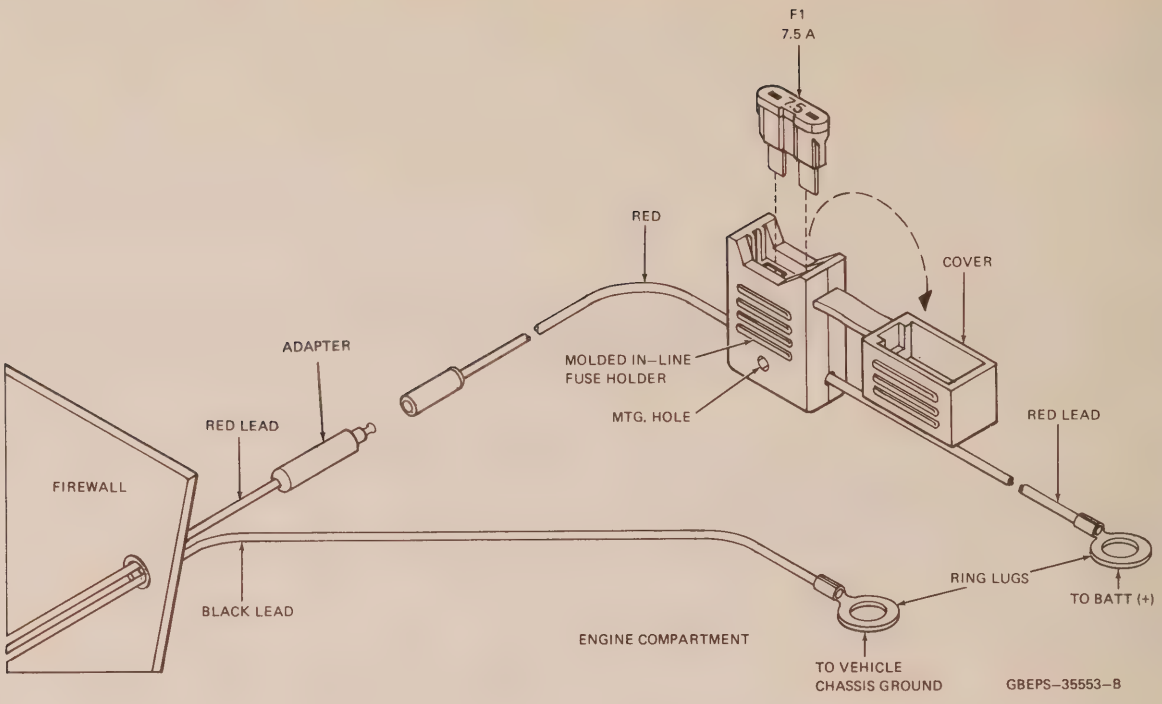


Figure 2. Power Cable Assembly

Step 5. Plug fuse into in-line fuse holder as shown in Figure 2.

Step 6. Install ring lugs (supplied) onto stripped end of power cable BLACK lead, and onto stripped end of RED lead on fuse holder as shown in Figure 2.

Step 7. Connect the fuse holder RED adapter lead plug to the mating receptacle on the RED lead of the power cable as shown in Figure 2.

Step 8. Connect the power cable BLACK lead directly to the vehicle chassis ground.

Step 9. Connect the power cable RED lead from the fuse holder to the positive (+) battery terminal. Make sure that the adapter cable is connected to the main power cable RED lead, and that the fuse is installed in the fuse holder before connecting to battery.

NOTE

Connecting the RED lead to the ignition switch is not recommended. If your installation requires using the ignition switch, a switching relay (Motorola part #59-813674) should be installed. Alternately, options B113AG Ignition Switch Cable and B308AA Accessory Plug may be installed.

Step 10. Locate the fuse holder as close to the power source as possible and away from any hot engine component. Mount the fuse holder using the provided mounting hole and dress wires as necessary.

3. MOBILE RADIOS USING HLN4426A LOCKING TRUNNION

3.1 MOUNTING CONSIDERATIONS

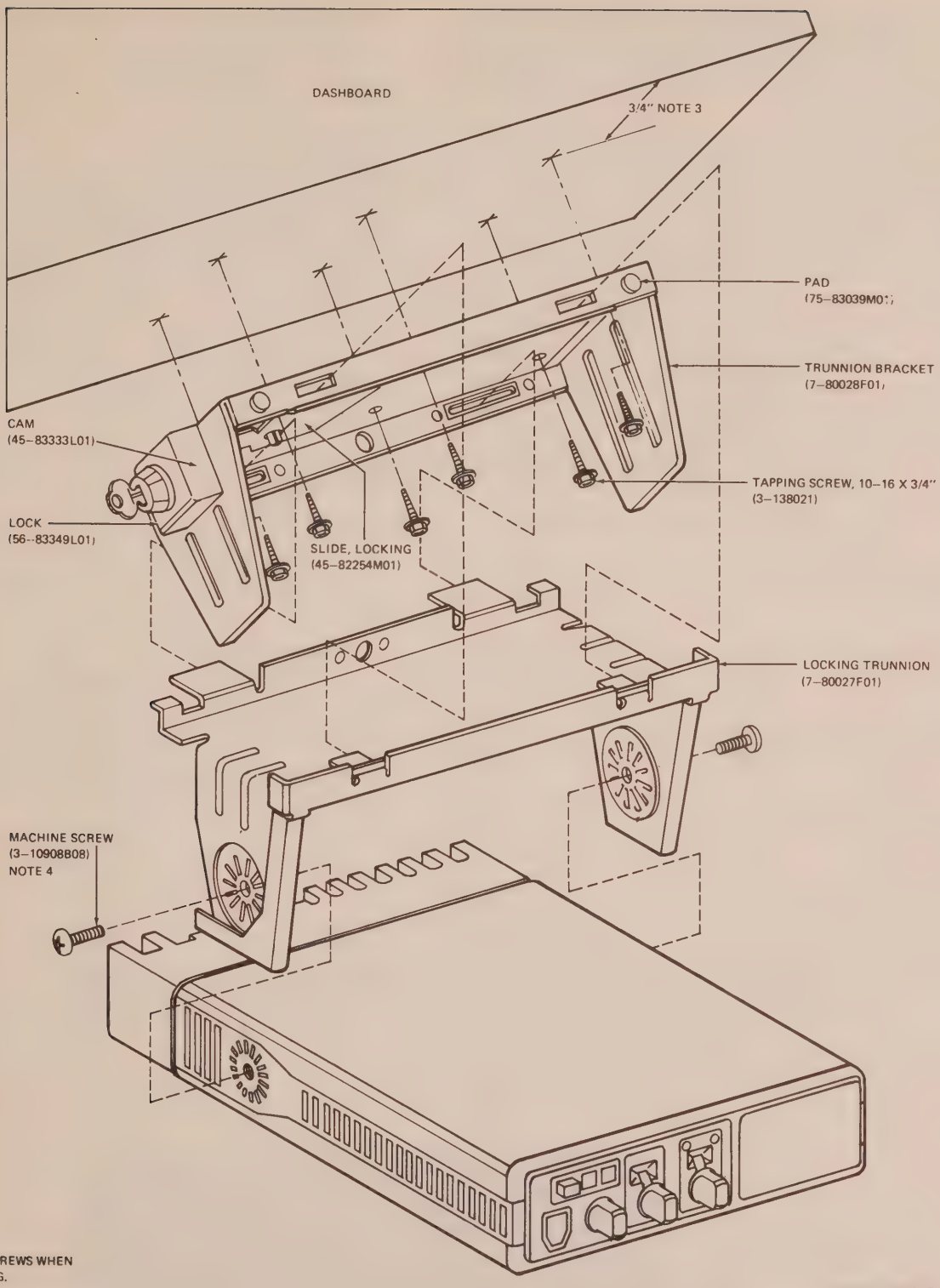
Before attempting to install the locking trunnion examine the vehicle for suitable mounting locations. The bracket requires a flat mounting surface at least 8" × 2" with adequate clearance for inserting the radio set. The chosen location should also be convenient to the vehicle operator and provide access to power and antenna connections. Be careful to choose a location which permits the locking trunnion to be removed from the mounting bracket. Vehicle operation should in no case be impaired.

3.2 INSTALLATION
(Refer to Figure 3)

Step 1. Using the mounting bracket as a template, drill six 5/32-inch holes. If mounting on plastic surface, use metal backing plate or select mounting position around metal dash supporting frame to strengthen installation.

Step 2. Using the six #10-16 × 3/4" screws provided, attach the mounting bracket to the mounting surface. Allow 3/4 inch clearance in front of the bracket so locking trunnion may be inserted in the radio.

Step 3. Attach radio to locking trunnion using the two M5.0 × .8 × 10 screws provided. These screws are slotted *TORX*® drive. Recommended driver size is T25.



NOTES:

1. USE ALL SCREWS WHEN INSTALLING.
2. MOTOROLA PART NUMBERS SHOWN IN PARENTHESIS.
3. ALLOW 3/4" CLEARANCE IN FRONT OF TRUNNION BRACKET TO PROVIDE ADEQUATE SPACE FOR LOCKING TRUNNION INSERTION.
4. IF OPTIONAL SECURITY SCREWS ARE USED, INSTALL IN PLACE OF MACHINE SCREW.

Figure 3. Locking Trunnion Mounting

Step 4. Insert the locking trunnion into the mounting bracket by first sliding the large flanges into the slots at the rear of the mounting bracket and then sliding the small locking flanges into the slots at the front of the mounting bracket.

Step 5. Lock the locking trunnion into the mounting bracket using the key provided.

Step 6. Perform Steps 2 through 8 in paragraph 4.

4. MOBILE RADIOS USING NON-LOCKING TRUNNION MOUNTING BRACKET HLN4427A

Step 1. Mount the radio set trunnion mounting bracket. See Figure 4.

Step 2. Mount the antenna, using the instructions provided with the antenna kit. Run the coaxial cable to the intended radio set mounting location. If necessary, cut off the excess cable and install the cable connector.

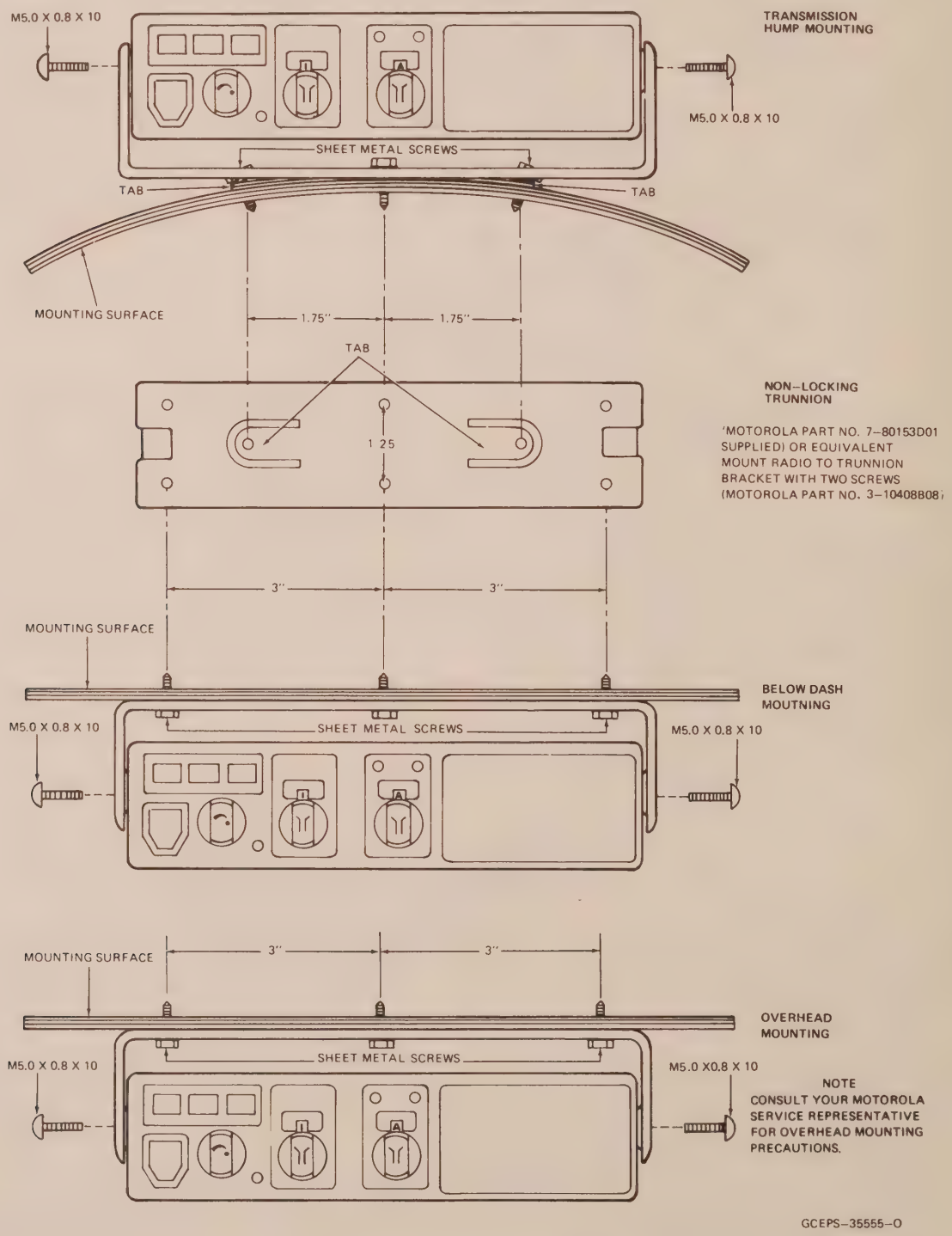


Figure 4. Radio Mounting Detail

Step 3. Mount the microphone hanger.

Step 4. Connect the power plug and coaxial cable connector to the radio set. See Figure 6. Install the radio in the mounting bracket.

Step 5. Complete the power wire routing. Be sure to leave sufficient slack wire behind the radio set to make the unit easy to remove and reinstall. Strap the wire down where necessary being sure the wires do not make contact with hot areas on the engine. Be sure the wires cannot be snagged by the operator's feet during normal vehicle operation.

Step 6. If a external speaker is used, secure wiring as needed. Allow sufficient slack in wiring for future maintenance.

Step 7. Connect the microphone to the radio in the following manner:

A. Grasp the microphone cable directly in front of the microphone connector gasket, making sure that the tapered edge is facing down. See Figure 5.

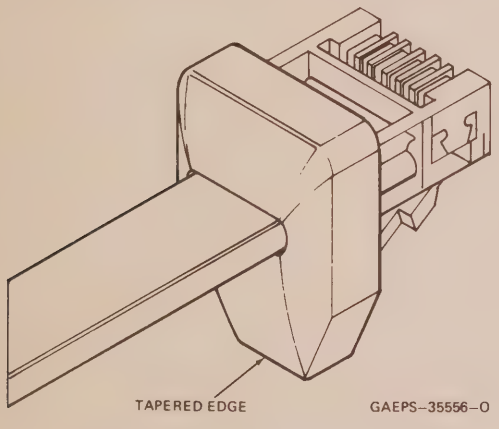


Figure 5. Microphone Connector Detail

B. Carefully insert the microphone connector into the mating receptacle on the radio front panel. A "click" will be heard when the connector is secured in place.

C. To remove the microphone connector from the radio, press up on the microphone connector gasket from the bottom side. It is not necessary to hold the gasket, as the connector will disengage without pulling on it. Once the connector is free of the receptacle, grasp the microphone cable and pull from radio front panel.

Step 8. Test radio and its accessories for proper system operation. Check the antenna VSWR, using an in-line wattmeter. Do **not** readjust power output with the in-line wattmeter connected to antenna at this time. Refer to Transmitter Power Output Adjustment Procedure in the Maintenance section of this manual.

5. CONTROL STATION INSTALLATION

Step 1. Attach the mounting feet to the bottom of the radio.

Step 2. Connect the power cable to the radio set and to the power supply output jack.

Step 3. Connect an in-line wattmeter between the radio antenna connector and the antenna system.

Step 4. Plug the base dc power supply into the 117 volt, 60 Hz outlet. Set the power supply AC POWER switch to the ON POSITION.

Step 5. Key the transmitter and check the antenna system VSWR. If the VSWR is 3:1 or lower, disconnect the wattmeter and connect the antenna coaxial cable to the radio set antenna jack. If VSWR is greater than 3:1, consult the literature supplied with the antenna.

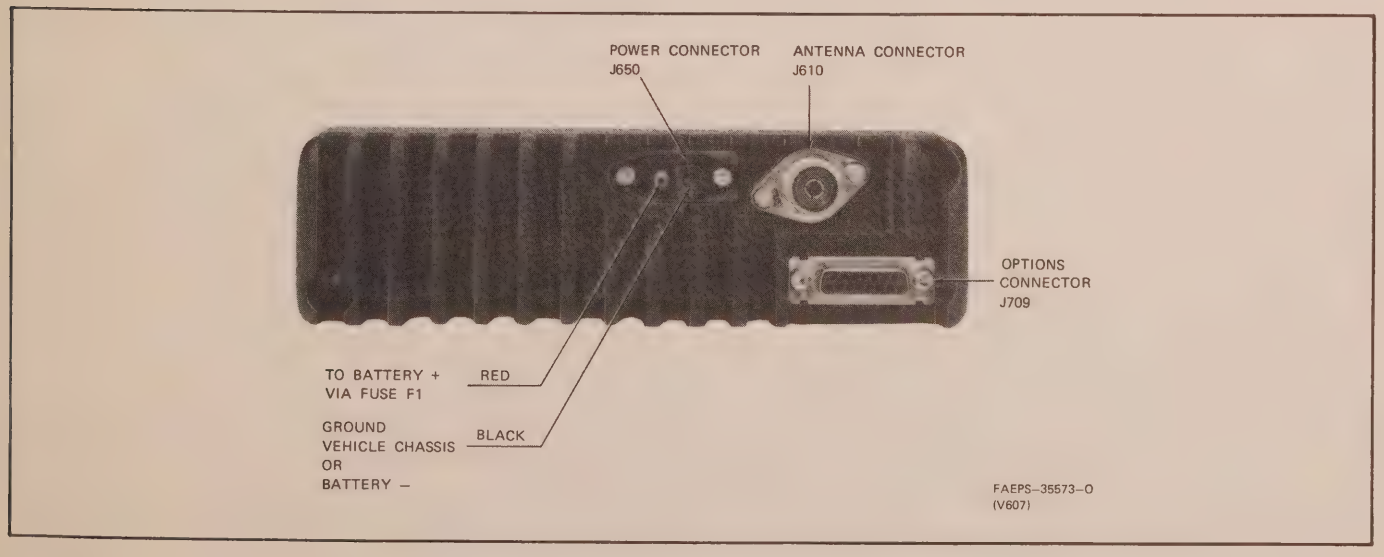


Figure 6. Connections to Radio Set Rear Panel

Step 6. Test the radio set and accessories for proper operation. A brief conversation with a mobile unit in your system will indicate whether the control station is operating satisfactorily.

6. ALTERNATOR WHINE SUPPRESSION

Occasionally, an installation may result in objectionably high alternator whine level, depending on the age and condition of the vehicle battery, alternator, or wiring. The following recommendations are designed to reduce alternator whine.

6.1 For radios where power is not connected through the vehicle's ignition switch, install the HKN4121B Ignition Switch Cable (part of Option B113AG) and the HLN4472A Options Connector (Option B308AA). Connect the HKN4121B cable between pin 7 of P709 and the *positive battery terminal* for optimum alternator whine supression. Also remove JU601 on the main board. If alternator whine level is still objectionable, add a TLN5277B Alternator Whine Filter in series with the HKN4121B cable.

6.2 For radios where power is connected through the vehicle's ignition switch via a HKN4121B cable (Option B113AG), install a TLN5277B Alternator Whine Filter between the ignition switch and the cable. If alternator whine is still objectionable, disconnect the TLN5277B Alternator Whine Filter from the ignition switch and reconnect it directly to the vehicle's battery; then install a switching relay (Motorola Part No. 59-813674) in series with the HKN4121B cable. Wire the relay coil to the ignition switch to provide the ignition switching function.

6.3 For radios which use only the switching relay for switch control, install a TLN5277B Alternator Whine Filter in series with the power cable (RED lead). If alternator whine is still objectionable change to option B113AG for ignition switch control and refer to paragraph 6.2.

THEORY OF OPERATION

The Theory of Operation section is divided into four parts. The first part contains a functional description of the four major areas of the radio:

- receiver
- transmitter
- synthesizer
- microcomputer and associated circuits.

This part includes a description of the functional blocks contained in each area as well as a separate block diagram for each area of the radio.

The second part of this section describes signal flow and functional block interaction for the following activities:

- initialization (turn-on)
- establishing a control channel
- receiving a call
- initiating a call
- failsoft operation

Included in this part is a functional block diagram of the entire radio.

The third part of this section contains a component level explanation of circuit operation for the unique circuits in the radio. Explanations are limited to circuits with which the reader may not be familiar or familiar circuits with unique features. Some simplified circuit diagrams are provided, but the schematic diagrams for the radio (which are included in the Diagrams and Ancillary Equipment section of this manual) should be referred to when reading the third part of the Theory of Operation section.

The fourth part of this section describes the functions of the microcomputer signals.

Additional theory of operation notes are located on the radio schematic diagrams.

An outline of the Theory of Operation section is provided below to aid the reader in finding information on a particular subject.

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68P81063E34-A

1. DESCRIPTION OF BASIC RADIO FUNCTIONS

1.1 RECEIVER — GENERAL DESCRIPTION
(Refer to Figure 1 Receiver Block Diagram)

The receiver is a dual-conversion type with inter mediate frequencies of 53.9 MHz and 10.7 MHz. Th factory-tuned preselector filter is sufficiently wide to ac commodate all frequencies within the 851 MHz t 870 MHz band without retuning. The receiver circuit are located on the main board.

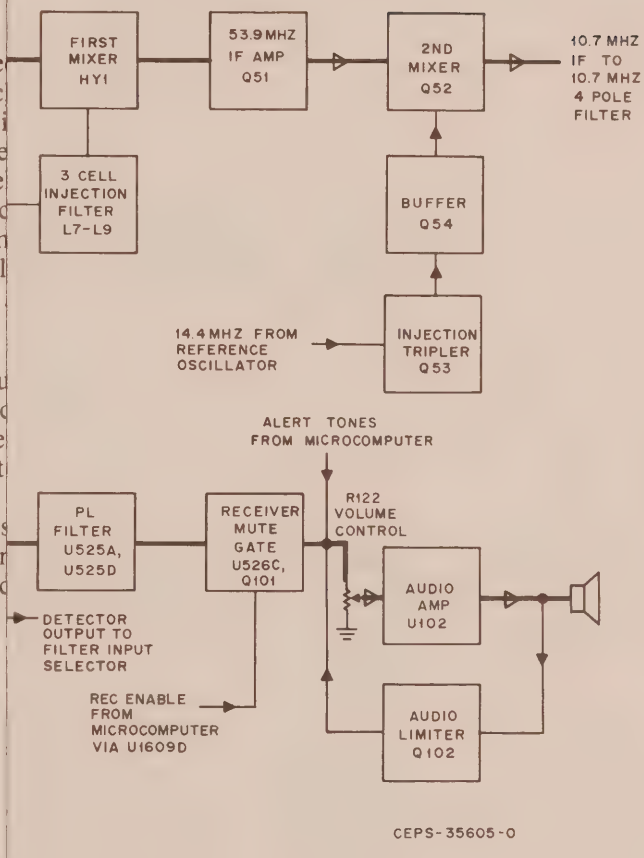
1.2 RECEIVER — GENERAL OPERATION

1.2.1 Front End and First Mixer

1.2.1.1 Incoming signals from the antenna are route to the 2-cell preselector via antenna switc CR700, CR701. The output of the 2-cell preselector i applied to rf preamplifier Q1. The preamplifie amplifies the rf signal and applies it to four-ce preselector L3-L6. The two-pole and four-pole preselec tors attenuate high-level out-of-band signals to preven degradation of receiver performance. The four-pol preselector applies the receive signal to first mixer HY1.

1.2.1.2 The T/R switch applies the synthesizer outpu to three-cell injection filter L7-L9. The injec tion filter is factory-tuned to pass frequencies betwee 797.1-816.1 MHz and applies the synthesizer output t the first mixer for low-side injection. Hybrid HY1 is balanced diode type mixer. The mixer generates a firs intermediate frequency of 53.9 MHz when the receive r and synthesizer output are applied to it. Low side injec tion is used, where $f_R - f_{LO} = 53.9$ MHz.

f_R = receive frequency
f_{LO} = synthesizer frequency



ock Diagram

1.2.2 First I-F Circuits and Second Mixer

1.2.2.1 The first mixer applies the 53.9 MHz i-f sign to 53.9 MHz i-f amplifier Q51. This amplifi is a common gate JFET (junction field-effect transisto amplifier that amplifies the i-f signal to a level sufficie to drive the second mixer.

1.2.2.2 The reference oscillator applies a 14.4 MH signal to injection tripler Q53. The tripler is class C bipolar transistor amplifier with an output ci cuit tuned at a fixed injection frequency of 43.2 MH The tripler applies the 43.2 MHz signal to buffer Q5 which in turn applies a low-side injection signal to se ond mixer Q52. The second mixer produces a second i signal of 10.7 MHz when the first i-f signal ar 43.2 MHz low-side injection signal are present.

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f_{LO} = synthesizer frequency

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1.2.3 Second I-F Circuits

1.2.3.1 Several stages of filtering and amplification are employed in the second i-f circuitry. Selective i-f filtering is achieved by using dual-resonator, mode-coupled monolithic crystals cut to a fundamental frequency of 10.7 MHz. No tuning is required in the second i-f circuitry.

1.2.3.2 The second mixer output is applied to 10.7 MHz four-pole filter Y100, Y101. The filtered i-f signal is applied to 10.7 MHz i-f amplifier Q55, U100. This i-f amplifier is a high gain JFET amplifier that applies the i-f signal to 10.7 MHz four-pole filter Y102, Y103. The four-pole filter applies the second i-f signal to the detector.

1.2.4 Audio Detector and Buffer

1.2.4.1 Audio detector U101 is a limiter/quadrature detector integrated circuit. The second i-f signal from Y102, Y103 is limited by U101 and detected by U101 and an external two-pole resonator filter Y104 (refer to main board schematic diagram). The detector routes the detected audio signal to buffer Q100.

1.2.4.2 Buffer Q100 is an emitter-follower circuit that applies the detected audio to the PL (*Private-Line* squelch) filter and to the filter input selector circuit. (The filter input selector circuit operation is described in the paragraphs that describe microcomputer operation.)

1.2.5 PL Filter and Mute Gate

PL filter U525A, D is an operational amplifier configured as a high-pass filter. The PL filter attenuates low-speed data signals that may be present in the detected audio. The PL filter applies the filtered audio to receiver mute gate U526C, Q101. The receiver mute gate applies filtered audio to the volume control and audio amplifier when enabled by the REC ENABLE signal from the microcomputer.

1.2.6 Audio Amplifier and Audio Limiter

Detected audio from receive mute gate U526C, Q101 and alert tones signals from the microcomputer are applied to audio amplifier U102. Amplifier U102 amplifies the audio signal and tones to a level sufficient for driving the radio speaker. The output of the audio amplifier is also applied to audio limiter Q102. The audio limiter limits the gain of amplifier U102 to ensure that the speaker is not overdriven.

NOTE

Audio is routed through JU709, on the rear of the radio and back to the internal speaker. JU709 is not used on radios with B18, B109, B488, or B700 options.

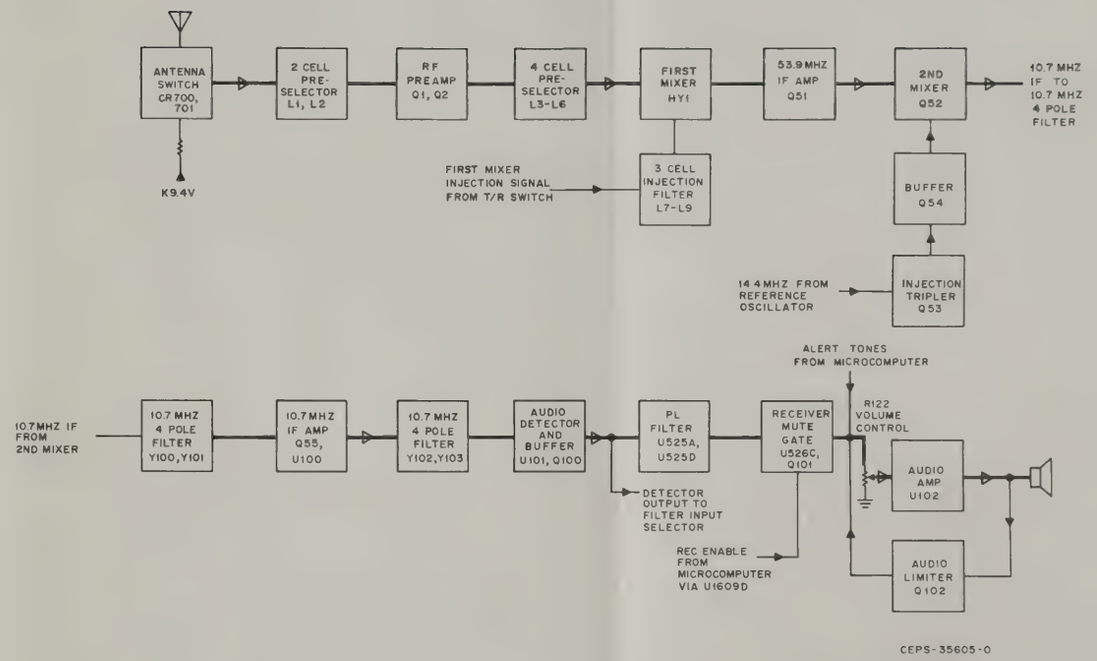

Figure 1. Receiver Block Diagram

The transmit rf and control circuits provide the following functions:

- power amplification
- rf output power control
- power amplifier circuit protection
- receive/transmit switching.

Frequency generating circuits for the transmitter are located in the synthesizer circuits which are discussed in another part of this manual section.

1.4 TRANSMITTER — GENERAL OPERATION

1.4.1 Transmitter Audio Circuits

1.4.1.1 Audio signals from the microphone are applied to mic mute gate U526A. The mic mute gate applies the audio signal to the pre-emphasis limiter only if the gate is enabled by a high level MIC MUTE signal from the microcomputer. The microcomputer disables this gate in the receive mode and during data transmissions.

1.4.1.2 The pre-emphasis limiter circuit (U525C) provides two functions:

- the transmit audio is pre-emphasized with a 6 dB/octave frequency response over a frequency range of 300-3000 Hz.

- the pre-emphasized transmit audio signal is limited to 7.5 volts peak-to-peak to prevent over modulation.

1.4.1.3 Splatter filter U525B is a low-pass filter (3 kHz). This filter attenuates the higher-order harmonics that are present in the pre-emphasized, limited transmit audio signal. The splatter filter applies the transmit audio signal to the deviation control (R1101). The deviation control setting determines the maximum transmit deviation level (after compensation control R1100 is set).

1.4.1.4 Transmit audio from the deviation control is applied to reference oscillator U1101 and to the VCO via R1100. The process of modulating both the VCO and the reference oscillator is called dual port modulation. Dual port modulation prevents a phase error from being generated in the synthesizer circuit as occurs when modulation is only applied to the VCO in single port modulation. Transmit audio from the deviation control is also applied to compensation control R1100. The compensation control adjusts the ratio of the reference oscillator modulation level to the VCO modulation level. The compensation control is set so that equal phase shifts are present at both inputs of the synthesizer phase detector during modulation.

1.4.1.5 The compensation control applies the transmit audio signal to the VCO circuit for modulation. The output of the VCO is a modulated rf signal at one-half the transmit frequency. The buffered output of the VCO is applied to a doubler circuit, a buffer circuit, and a T/R switch. The T/R switch applies the modulated synthesizer output (at the transmit frequency) to the transmit rf circuits.

NOTE

The synthesizer is fully described in another paragraph of this manual section. A description of the doubler, buffer, and T/R switch is inlcuded in the synthesizer description.

1.4.2 Transmitter RF and Control Circuits

1.4.2.1 The transmit/receive (T/R) switch applies the modulated rf signal to intermediate power amplifier Q250. The CONTROL VOLTAGE signal from the power control circuit (Q660-Q662) determines the gain of the intermediate power amplifier. When the radio is in the receive mode, the T/R switch applies the synthesizer output to the receiver circuits and no rf signal is applied to the intermediate power amplifier (IPA).

1.4.2.2 The IPA applies the modulated rf signal to power amplifier module U600. The power amplifier module is a three-stage amplifier. The CONTROL VOLTAGE signal from the power control circuit (Q660-Q662) controls the gain of the first amplifier stage. Battery voltage is applied from connector J650 to power the second and third stages. The third amplifier stage applies the transmit rf signal to the antenna switch. In the transmit mode, the antenna switch routes the transmit rf signal to the antenna jack (J610).

1.4.2.3 A signal proportional to the output current of the third stage is applied to the power control circuit. Also, a thermistor (RT600) mounted on the power amplifier module flange is used to vary the signal on the CURRENT/TEMP SENSE line as the temperature varies. The CURRENT/TEMP SENSE signal is applied to the power control circuit.

1.4.2.4 The power control circuit is used to control the gain and operation of the IPA and the power amplifier module. The CONTROL VOLTAGE signal controls the gain of the IPA and the first stage of the power amplifier module. The power control circuit varies the level of CONTROL VOLTAGE in response to the CURRENT/TEMP SENSE and LOW CURRENT BATT A+ signals applied by the power amplifier module. CONTROL VOLTAGE reduces IPA and power amplifier module gain when the final current, power ampliifier module temperature, or battery voltage is too high.

1.4.2.5 The CONTROL VOLTAGE signal is applied to the power amplifier module and IPA when the power control circuitry is enabled by PA enable switch Q1607. PA enable switch operation is described in the microcomputer operation description. Transmission is only possible when the power control circuitry is enabled.

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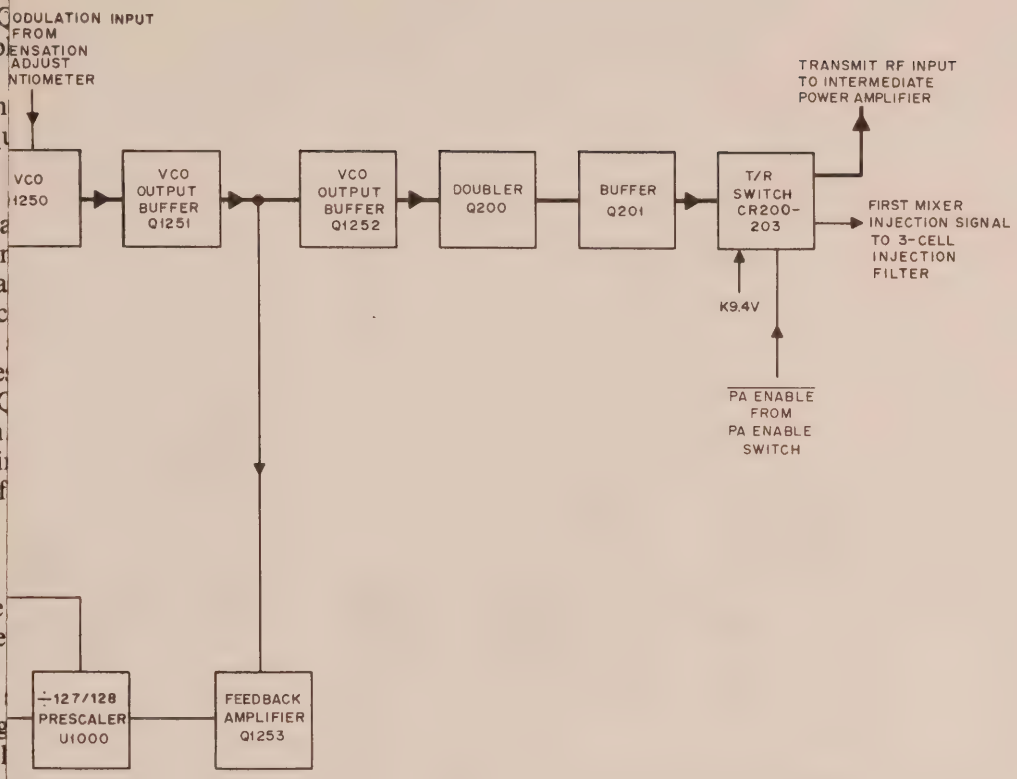

1.3 TRANSMITTER — GENERAL DESCRIPTION (Refer to Figure 2 Transmitter Block Diagram)

The transmitter is capable of supplying greater than 15 watts of rf output power into a 50-ohm load. The transmitter circuits can be divided into two groups: transmit audio circuits and transmit rf and control circuits. The transmit audio circuits provide the following functions:

- muting
- limiting
- filtering
- deviation and compensation adjustment.

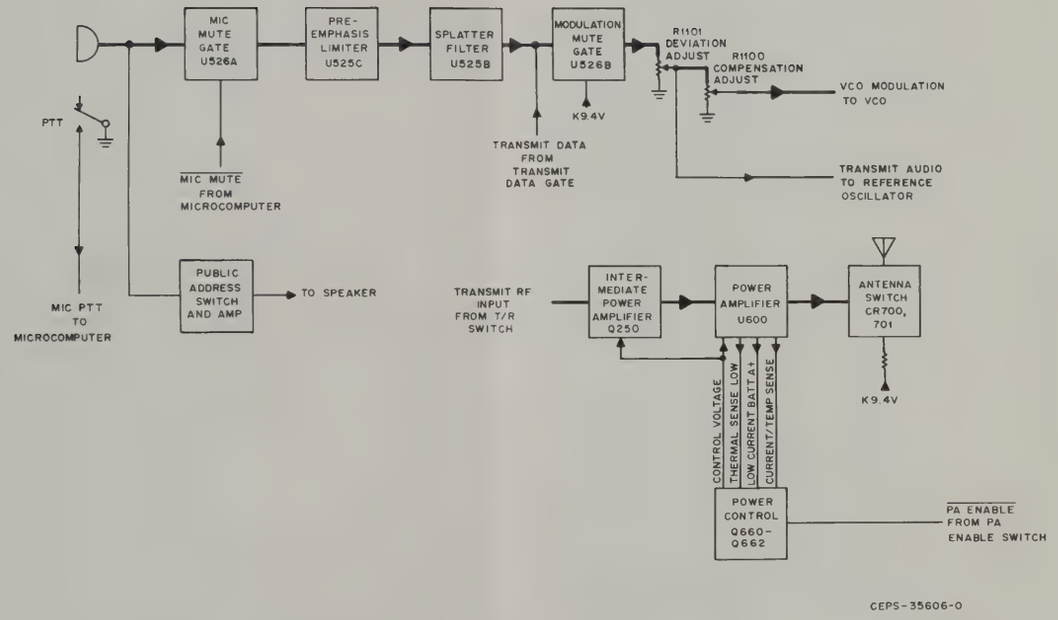

Figure 2. Transmitter Block Diagram

The transmit rf and control circuits provide the following functions:

- power amplification
- rf output power control
- power amplifier circuit protection
- receive/transmit switching.

Frequency generating circuits for the transmitter are located in the synthesizer circuits which are discussed in another part of this manual section.

1.4 TRANSMITTER — GENERAL OPERATION

1.4.1 Transmitter Audio Circuits

1.4.1.1 Audio signals from the microphone are applied to mic mute gate U526A. The mic mute gate applies the audio signal to the pre-emphasis limiter only if the gate is enabled by a high level MIC MUTE signal from the microcomputer. The microcomputer disables this gate in the receive mode and during data transmissions.

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- the transmit audio is pre-emphasized with a 6 dB/octave frequency response over a frequency range of 300-3000 Hz.

- the pre-emphasized transmit audio signal is limited to 7.5 volts peak-to-peak to prevent over modulation.

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1.4.2.5 The CONTROL VOLTAGE signal is applied to the power amplifier module and IPA when the power control circuitry is enabled by PA enable switch Q1607. PA enable switch operation is described in the microcomputer operation description. Transmission is only possible when the power control circuitry is enabled.

1.5 SYNTHESIZER — GENERAL DESCRIPTION
(Refer to Figure 3 Synthesizer Block Diagram)

The synthesizer and associated circuits generate the rf frequencies required for the transmitter and for receive first mixer injection. Frequency modulation also takes place in the synthesizer. The synthesizer and associated circuits can be divided into four basic parts. A phase-locked loop, a reference oscillator, a frequency doubler circuit, and a transmit/receive switch. The phase-locked loop circuit is located on the trunked command board; all other synthesizer related circuits are located on the main board.

1.6 SYNTHESIZER — GENERAL OPERATION

1.6.1 14.4 MHz Reference Oscillator and Buffer

14.4 MHz reference oscillator U1101 is located on the main board and is a temperature compensated channel element with a frequency stability of ±2.5 ppm. The oscillator applies a 14.4 MHz signal to buffer Q1100, and to a tripler circuit for the second mixer receiver injection. The buffer output is applied to the phase-locked loop integrated circuit to generate the channel reference frequency (6.25 kHz).

1.6.2 Phase-Locked Loop Circuits

1.6.2.1 The phase-locked loop circuits include a phase-locked loop (PLL) integrated circuit, charge pump, loop filter, voltage-controlled oscillator (VCO), feedback amplifier, two dual-modulus prescalers, a loss of lock detector, and buffer stages. The phase-locked loop integrated circuit contains three programmable counters and phase and frequency detection circuitry. The phase-locked loop employs dual port broadband audio modulation to provide flat response modulation in the audio frequency range of 1 Hz to 3000 Hz.

1.6.2.2 The phase-locked loop generates the desired transmit or receive first injection frequency by controlling the output frequency of the VCO. The VCO and the reference oscillator outputs are frequency divided by a set of programmable counters. The counters are programmed so that both oscillator frequencies are divided down to 6.25 kHz when the VCO output is at the desired frequency. The phases of the two 6.25 kHz signals are compared and a change in control voltage proportional to the phase error is applied to the VCO to "correct" any VCO frequency error.

1.6.2.3 Phase-locked loop operation requires a sequence consisting of two basic operations: programming the programmable counters and generating the desired synthesizer frequency. The microcomputer loads the programming information into the PLL integrated circuit to set up the loop to generate a specific frequency. The loop generates the specified frequency until the PLL integrated circuit is re-programmed by the microcomputer.

1.6.2.4 Please refer to the detailed functional block diagram of the PLL integrated circuit in Figure 3 during the following discussion. The microcomputer programs the PLL integrated circuit via three address lines (A0-A2), four data lines (D0-D3), and a strobe line (SYN STROBE). Programming data for the programmable counters is loaded into eight latches (L0-L7) on the PLL integrated circuit. The microcomputer writes the programming data into the PLL integrated circuit one latch at a time. After the microcomputer loads data into all eight latches, the PLL integrated circuit is programmed, and the synthesizer is ready to generate a transmit or receiver first injection frequency.

1.6.2.5 The VCO (Q1250) is an FET rf oscillator capable of generating any frequency between 398.5 and 412.5 MHz. The output frequency of the VCO is proportional to the steering line voltage applied by the loop filter. The VCO applies the rf signal to a buffer, Q1251, which, in turn, applies the rf signal to the feedback path and to the doubler, buffer, T/R switch circuits via buffer Q1252.

1.6.2.6 Feedback amplifier Q1253 amplifies the output of buffer Q1251 and applies it to prescaler U1000. Prescaler U1000 is a dual-modulus prescaler that divides the VCO output frequency by either 127 or 128. The output of U1000 is applied to pin 3 of the PLL integrated circuit.

1.6.2.7 The ÷127/128 prescaler divide count is controlled by the modulus control signal (MOD CON) from pin 14 of the PLL integrated circuit. The MOD CON level is low at the beginning of the count cycle and remains low until the ÷A counter counts down from the programmed value (A).

1.6.2.8 After the ÷A counter counts down, the MOD CON line is high, and remains high until the ÷N counter counts down from the programmed value (N). This provides a total programmed divide value of $N_T = (127 \times N) + A$ at the output of the ÷N counter.

1.6.2.9 In the PLL integrated circuit, the binary value of N is stored in latches L2, L3, L4 and the value of A is stored in latches L0, L1. The microcomputer programs the PLL integrated circuit dividers so that when the VCO frequency is correct, the input to phase detector A is 6.25 kHz.

1.6.2.10 The 14.4 MHz reference oscillator buffer applies the reference signal to pin 7 of the PLL integrated circuit, where it is applied to the 12-bit ÷R counter. The microcomputer always loads latches L5, L6, L7 with a value for R that results in a counter output of 6.25 kHz.

1.6.2.11 The outputs of both the ÷R counter and the ÷N counter are applied to phase detector A. The output of phase detector A is applied to phase detector B. Phase detector B applies two signals (ΦV and ΦR) to charge pump Q1001-Q1004. The output current of the charge pump is applied to the loop filter which generates the dc control voltage for the VCO (STEERING LINE voltage). The STEERING LINE voltage determines the VCO frequency by setting the dc voltage applied to two varactors.

1.6.2.12 When the phase error at phase detector A is reduced and the frequency of the VCO is stabilized at the frequency programmed by the microcomputer, the synthesizer is "locked". PLL integrated circuit pin 13 output consists of a logic high level with very narrow negative-going pulses when the synthesizer is locked. Loss of lock detector Q1005-Q1008 applies a logic low to the PA enable switch. When the synthesizer is out of lock, a low level pulsating dc signal present at pin 13. The output of the loss of lock detector is high, inhibiting the PA enable switch.

1.6.2.13 In the transmit mode, the transmit audio signal is applied to the modulation input of both the VCO and the reference crystal oscillator. The application of the transmit audio signal to both modulation inputs, in a prescribed voltage ratio, is necessary to produce a synchronous and equal phase shift at the two 6.25 kHz input lines to phase detector A. This eliminates the corrective reaction of the phase-locked loop to the VCO frequency modulation deviation. The prescribed ratio of one modulation input voltage to the other is set by the position of compensation potentiometer R1100. Deviation potentiometer R1101 sets the maximum allowable system frequency deviation after the compensation control is set.

1.6.2.14 The modulated VCO output is applied to frequency doubler Q200 via VCO output buffers Q1251, Q1252. The doubler doubles the frequency of the VCO signal. Buffer Q201 applies the doubler output to the T/R switch CR200-203. If k9.4 V is at a logic high level and PA ENABLE is at a logic low level, the T/R switch applies the doubler output to the transmit rf circuits. If k9.4 V is at a logic low and PA ENABLE is at a logic high, the T/R switch applies the doubled VCO output to the receiver first mixer via an injection filter.

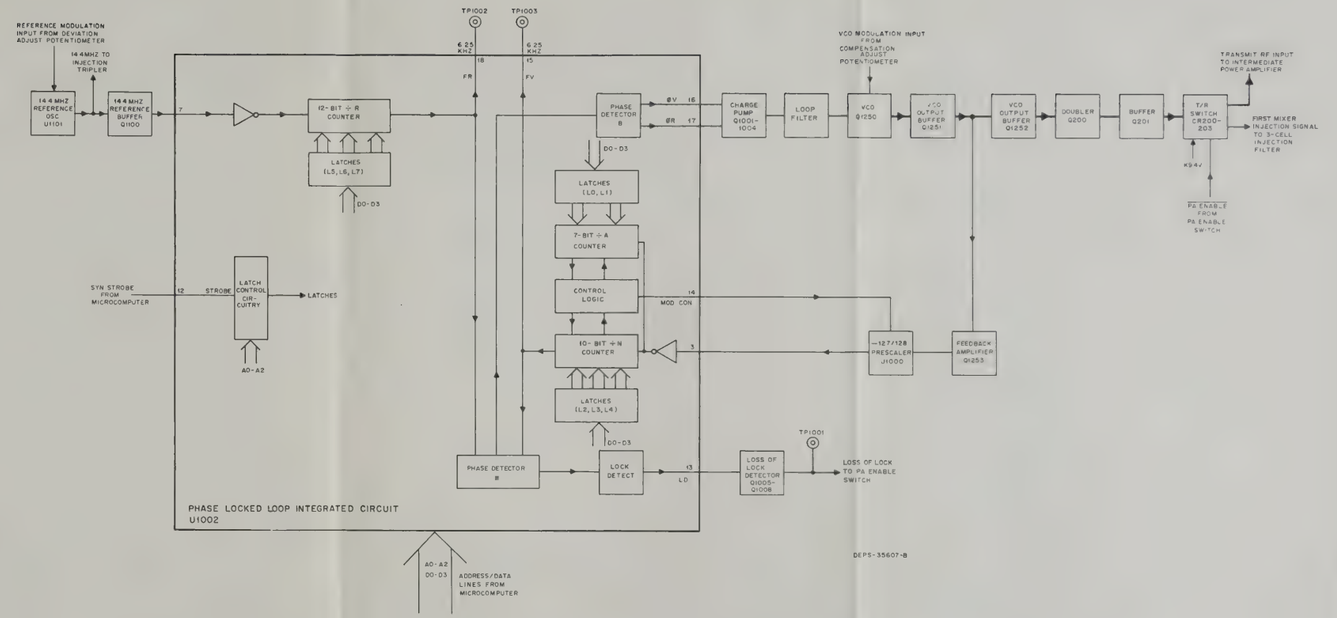

Figure 3. Synthesizer Block Diagram

506D, B, C), a high speed filter A, B), a center slicer (U1603B; 508C), and a transmit data gate de the proper routing and shaping of

Mode, High Speed Data

nputer pin 27 applies a logic low to output of U1609A enables filter input select the high speed filter path. The ath begins at microcomputer pin 26 gh speed filter via U1604. (The low egins at pin 26 and goes to the high low speed attenuator, the filter input ow speed filter.) The microcomputer transmit data to the high speed filter filter path. The high speed filter ap- to transmit data gate U1608A. A the keyed 9.4 V driver enables the to apply the transmit data to the uits for modulation.

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1.8.8 Receiver Audio Enable and Alert Tones

The microcomputer generates all of the alert tones used as audible indicators to the operator (except the failsoft tone). Tones are routed from pin 9 of microcomputer U1601 to the volume control and heard in the speaker. When the tones are generated, microcomputer pin 11 goes high driving the output of U1609D low. The low output of U1609D (REC MUTE) is applied to the receive mute gate which prevents the receive signal from being applied to the volume control while tones are being generated.

1.8.9 Watchdog Timer

The watchdog timer verifies microcomputer operation. When the microcomputer is operating, a pulse is regularly applied to the watchdog timer by microcomputer pin 30. This pulse restarts the timer. If the timer is not regularly restarted, the timer applies a reset signal to the microcomputer and the microcomputer begins a start-up routine (initialization).

1.8.10 Reset Delay

Upon initial power up, the reset delay circuit holds the $\overline{\text{RESET}}$, pin 2, of the microcomputer low for a period of 220 microseconds. This assures proper initialization of microcomputer output ports.

1.8.11 Call Light Indicator

When pin 28 of the microcomputer goes low, the call light indicator is activated.

1.8.12 Volume Set Switch

When the volume set pushbutton is depressed, a low is applied to pin 20 of the microcomputer which causes it to apply a continuous tone to the speaker so the operator can adjust the volume.

1.8.13 External Alarm and Buffer Switch

Microcomputer pin 29 applies a logic low to U1609B when an external alarm is in progress. The high output of U1609B is applied to the external alarm buffer Q1610, and switch, Q1611.

2. DESCRIPTION OF RADIO FUNCTIONS
(Refer to Figure 5 Radio Block Diagram)

2.1 TURN-ON AND INITIALIZATION

2.1.1 Power is applied to the radio circuitry by the on-off switch which is mechanically connected to the volume control. Watchdog timer U1603 applies a logic low reset signal to microcomputer pin 2 for 300 milliseconds. After reset, the microcomputer begins an initialization sequence. For 600 milliseconds after reset, the microcomputer tests the watchdog timer by applying pulses to the TICKLE signal line (pin 30). A failure of the watchdog timer because it is malfunctioning or because the microcomputer is not generating the proper TICKLE signal results in a reset signal being applied to the microcomputer. The reset signal causes the microcomputer to begin the initialization process again.

2.1.2 After the watchdog timer test is successfully completed, the microcomputer begins addressing memory locations in the code plug (pins 33-40). As each location is addressed, the data from the location is applied to the microcomputer (pins 21-24). Data from the code plug is stored in the microcomputer internal memory. The data read from the code plug includes the frequency setting information for four control channels, system identification, and fleet and subfleet identification.

2.2 ESTABLISHING A CONTROL CHANNEL

2.2.1 The microcomputer addresses the eight latches in the PLL integrated circuit one latch at a time. As each latch is addressed and the SYN STROBE is activated, data is loaded into the latch. The binary values loaded into the PLL integrated circuit latches determine the frequency generated by the synthesizer. The process of addressing and loading these latches is referred to as "programming the synthesizer".

2.2.2 The microcomputer first programs the synthesizer to produce the injection frequency required for the first control channel. The synthesizer locks on the required injection frequency and the receiver begins operating on the control channel. The audio detector and buffer applies the detected audio to the filter input selector. Microcomputer pin 27 applies a logic low to U1609A to select the high speed data path through the filter input selector. The high speed filter and center slicer shape and filter the receive signal and apply it to the microcomputer (pin 25). If the microcomputer is able to decode the receive signal, and the signal is a stream of outbound signal words (OSW's) with the proper system ID, the receiver remains on the channel until a call is received or the operator initiates a call (or transmission). OSW's are continuously present on the control channel for synchronizing the microcomputer to the system controller. The time period for each OSW is 23.3 milliseconds, and approximately every three seconds the OSW contains the system ID.

2.2.3 If the microcomputer is unable to decode the receive signal over a period of 200 milliseconds, or if the system ID is not valid, the microcomputer programs the PLL integrated circuit for the second control channel injection frequency. The microcomputer attempts to decode an OSW on the second control channel receive signal as previously described for the first channel. The microcomputer continues to attempt to decode a valid OSW on each control channel until all four channels are tried eight times or until there is a valid OSW decoded (indicating reception of a valid control channel.) If a valid OSW is decoded, the receiver remains on the control channel on which the valid OSW is received.

2.2.4 The sequence of monitoring all four control channels eight times is attempted 4 times. If a valid OSW is not decoded, the microcomputer begins the initialization sequence as previously described.

2.2.5 If the code plug contains the optional failsoft information, the above sequence is changed as follows. After the sequence when each control channel is selected eight times, the failsoft channel is selected. If a failsoft low speed handshake word is decoded, the radio goes into the failsoft mode which is described later in this section. If a failsoft low speed handshake word is not decoded, the sequence to find the control channel is resumed.

2.3 RECEIVING A CALL

2.3.1 A stream of OSW's is continuously present on the the control channel with an OSW occuring every 23.3 milliseconds. When the microcomputer decodes the OSW, it checks for channel assignment for a voice channel. This information includes the data for programming the synthesizer for the receiver injection frequency required for this voice channel. If a channel assignment for a voice channel is present, the microcomputer addresses and loads the PLL integrated circuit latches for the voice channel injection frequency. Microcomputer pin 27 is low to select the high speed data path. The detector output is applied to the microcomputer via the high speed data path and the center slicer.

2.3.2 The microcomputer attempts to decode the output of the center slicer. If the receiver is on a valid voice channel, and if a high speed handshake signal is received and then decoded by the microcomputer, microcomputer pin 26 goes high to select the low speed data path. The detected signal is applied to the low speed filter via the filter input selector. The signal is filtered and shaped by the low speed filter and center slicer. The microcomputer attempts to decode the output of the center slicer. If a low speed handshake is detected, microcomputer pin 11 goes low to enable detected audio to be applied to the speaker via the receive mute gate.

2.3.3 If a high speed handshake signal is not decoded, microcomputer pin 26 goes high to select the low

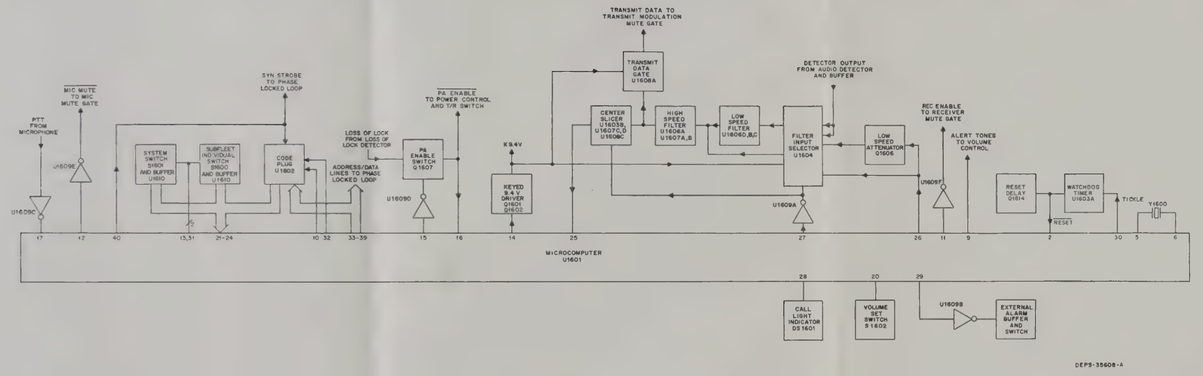

Figure 4. Microcomputer Circuits Block Diagram

1.7 MICROCOMPUTER AND ASSOCIATED CIRCUITS — GENERAL DESCRIPTION (Refer to Figure 4 Microcomputer Circuits Block Diagram)

Microcomputer U1601 and associated circuits:

- contain channel and system operation information (information is stored in microcomputer internal memory and code plug PROM)
- provides interfaces between the operator controls and indicators and the radio
- generates alert tones
- controls audio (receive and transmit) mute circuits
- enables power amplifier circuits
- encodes, decodes, filters, and controls routing for system data signals
- verifies microcomputer integrated circuit activity
- controls antenna switch and T/R switch.

1.8 MICROCOMPUTER AND ASSOCIATED CIRCUITS — GENERAL OPERATION

1.8.1 PTT Circuit

When the microphone PTT button is depressed, a logic low is applied to U1609C, which in turn applies a logic high to pin 17 of the microcomputer.

1.8.2 Microphone Mute Circuit

When pin 12 of the microcomputer is high, the output of U1609E goes low to mute the transmit audio circuits. This is generally done to prevent voice signals from modulating transmit rf when the microcomputer is modulating the transmit rf signal with data or tones.

1.8.3 System and Subfleet/Individual Switches

Switches S1601 and S1600 are mounted on the front panel of the radio. The outputs for these switches are applied to the microcomputer via buffer U1610. Pins 13 and 31 of the microcomputer control the outputs of buffer U1610 so that the outputs of only one switch are applied to the microcomputer at any time.

1.8.4 Code Plug

1.8.4.1 Code plug U1602 is a PROM (programmable read-only memory) integrated circuit. This PROM contains the data that determines the frequency of the system control channels, subfleet and fleet members, and other system related information.

1.8.4.2 Memory locations in the PROM are selected (addressed) by pins 33 through 40 and pin 10 of the microcomputer. The data in the addressed memory location is applied to pins 21-24 of the microcomputer when the code plug is enabled by pin 32. Data from the code plug is stored in the computer internal memory after initialization.

1.8.5 Address/Data Lines to Synthesizer

Pins 33-39 of the microcomputer apply address and data information to the PLL integrated circuit in the radio synthesizer. A synthesizer strobe signal (pin 40) enables the addressed PLL latches to load (read) the data applied by the microcomputer. This data programs the synthesizer to generate the correct receiver injection or transmit frequency. Addressing and loading of data is discussed in the synthesizer paragraphs of this instruction manual section.

1.8.6 Power Amplifier Control

The microcomputer controls the power amplifier and other transmit circuits via the PA enable switch (Q1607) and the keyed 9.4 V (k9.4 V) driver (Q1601, Q1602). When transmission occurs the loss of lock signal must be a logic low, indicating a synthesizer lock condition. The microcomputer must apply a logic low to U1609D, which in turn applies a logic high to Q1607 base. The output of Q1607 (collector) is a logic low that enables the power amplifier via the power control circuit. Pin 14 of the microcomputer goes high to enable keyed 9.4 V driver Q1601, Q1602. The output of the keyed 9.4 V driver:

- enables the antenna switch to route the power amplifier output to the antenna jack
- enables the modulation mute gate to apply transmit audio to the synthesizer for modulation
- enables the T/R switch to apply the synthesizer output to the intermediate power amplifier
- enables transmit data gate and filter input selector.

Note that the output of the PA enable switch, Q1607, is applied to pin 16 of the microcomputer. This allows the microcomputer to monitor the operation of the PA enable switch.

1.8.7 Trunked System Signals Processing Circuits

1.8.7.1 General Description

The trunked system signaling format requires the processing of both high and low speed data in both the transmit and receive modes. A filter input selector (U1604) controlled by the microcomputer works in conjunction with a low speed attenuator (Q1606), a low speed filter (U1606D, B, C), a high speed filter (U1606A; U1607A, B), a center slicer (U1603B; U1607C, D; U1608C), and a transmit data gate (U1608A) to provide the proper routing and shaping of these data signals.

1.8.7.2 Transmit Mode, High Speed Data

Microcomputer pin 27 applies a logic low to U1609A; the high output of U1609A enables filter input selector U1604 to select the high speed filter path. The high speed filter path begins at microcomputer pin 26 and goes to the high speed filter via U1604. (The low speed filter path begins at pin 26 and goes to the high speed filter via the low speed attenuator, the filter input selector, and the low speed filter.) The microcomputer applies high speed transmit data to the high speed filter via the high speed filter path. The high speed filter applies transmit data to transmit data gate U1608A. A k9.4 V signal from the keyed 9.4 V driver enables the transmit data gate to apply the transmit data to the transmit audio circuits for modulation.

1.8.7.3 Transmit Mode, Low Speed Data

Microcomputer pin 27 applies a logic high to U1609A; the low output of U1609A enables filter input selector U1604 to select the low speed filter path. The microcomputer applies low speed transmit data to the low speed filter path. The keyed 9.4 V signal enables the transmit data gate to apply the low speed data to the transmit audio circuits.

1.8.7.4 Receive Mode, High Speed Data

Microcomputer pin 27 applies a logic low to U1609A; the high output of U1609A enables the filter input selector to select the high speed filter path. In the receive mode, the high speed filter path is from the detector to the high speed filter via the filter input selector (bypassing the low speed filter). The audio detector and buffer applies the detector output to the high speed filter via the high speed filter path. The high speed filter applies the detector output to the center slicer where it is applied to the microcomputer (pin 25) for decoding. The transmit data gate is not enabled.

1.8.7.5 Receive Mode, Low Speed Data

Microcomputer pin 27 applies a logic high to U1609A, the low output of U1609A enables filter input selector U1604 to select the low speed filter path. In the receive mode, the low speed filter path is from the audio detector and buffer to the high speed filter via the filter input selector and low speed filter. The detector output is applied to the microcomputer via the low speed filter path, the high speed filter and the center slicer. The microcomputer decodes the data signals that are present in the center slicer output. The transmit data gate is not enabled.

1.8.8 Receiver Audio Enable and Alert Tones

The microcomputer generates all of the alert tones used as audible indicators to the operator (except the failsoft tone). Tones are routed from pin 9 of microcomputer U1601 to the volume control and heard in the speaker. When the tones are generated, microcomputer pin 11 goes high driving the output of U1609D low. The low output of U1609D (REC MUTE) is applied to the receive mute gate which prevents the receive signal from being applied to the volume control while tones are being generated.

1.8.9 Watchdog Timer

The watchdog timer verifies microcomputer operation. When the microcomputer is operating, a pulse is regularly applied to the watchdog timer by microcomputer pin 30. This pulse restarts the timer. If the timer is not regularly restarted, the timer applies a reset signal to the microcomputer and the microcomputer begins a start-up routine (initialization).

1.8.10 Reset Delay

Upon initial power up, the reset delay circuit holds the RESET, pin 2, of the microcomputer low for a period of 220 microseconds. This assures proper initialization of microcomputer output ports.

1.8.11 Call Light Indicator

When pin 28 of the microcomputer goes low, the call light indicator is activated.

1.8.12 Volume Set Switch

When the volume set pushbutton is depressed, a low is applied to pin 20 of the microcomputer which causes it to apply a continuous tone to the speaker so the operator can adjust the volume.

1.8.13 External Alarm and Buffer Switch

Microcomputer pin 29 applies a logic low to U1609B when an external alarm is in progress. The high output of U1609B is applied to the external alarm buffer Q1610, and switch, Q1611.

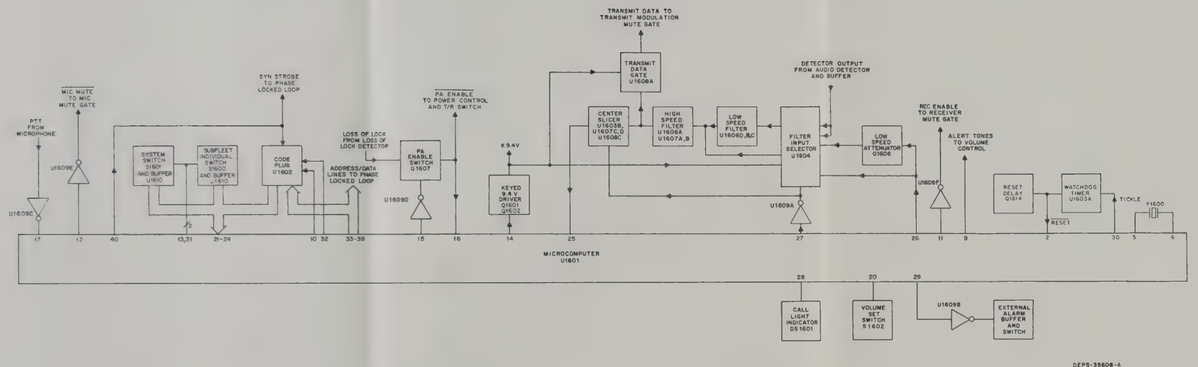

Figure 4. Microcomputer Circuits Block Diagram

1.7 MICROCOMPUTER AND ASSOCIATED CIRCUITS — GENERAL DESCRIPTION (Refer to Figure 4 Microcomputer Circuits Block Diagram)

Microcomputer U1601 and associated circuits:

- contain channel and system operation information (information is stored in microcomputer internal memory and code plug PROM)
- provides interfaces between the operator controls and indicators and the radio
- generates alert tones
- controls audio (receive and transmit) mute circuits
- enables power amplifier circuits
- encodes, decodes, filters, and controls routing for system data signals
- verifies microcomputer integrated circuit activity
- controls antenna switch and T/R switch.

1.8 MICROCOMPUTER AND ASSOCIATED CIRCUITS — GENERAL OPERATION

1.8.1 PTT Circuit

When the microphone PTT button is depressed, a logic low is applied to U1609C, which in turn applies a logic high to pin 17 of the microcomputer.

1.8.2 Microphone Mute Circuit

When pin 12 of the microcomputer is high, the output of U1609E goes low to mute the transmit audio circuits. This is generally done to prevent voice signals from modulating transmit rf when the microcomputer is modulating the transmit rf signal with data or tones.

1.8.3 System and Subfleet/Individual Switches

Switches S1601 and S1600 are mounted on the front panel of the radio. The outputs for these switches are applied to the microcomputer via buffer U1610. Pins 13 and 31 of the microcomputer control the outputs of buffer U1610 so that the outputs of only one switch are applied to the microcomputer at any time.

1.8.4 Code Plug

1.8.4.1 Code plug U1602 is a PROM (programmable read-only memory) integrated circuit. This PROM contains the data that determines the frequency of the system control channels, subfleet and fleet members, and other system related information.

1.8.4.2 Memory locations in the PROM are selected (addressed) by pins 33 through 40 and pin 10 of the microcomputer. The data in the addressed memory location is applied to pins 21-24 of the microcomputer when the code plug is enabled by pin 32. Data from the code plug is stored in the computer internal memory after initialization.

1.8.5 Address/Data Lines to Synthesizer

Pins 33-39 of the microcomputer apply address and data information to the PLL integrated circuit in the radio synthesizer. A synthesizer strobe signal (pin 40) enables the addressed PLL latches to load (read) the data applied by the microcomputer. This data programs the synthesizer to generate the correct receiver injection or transmit frequency. Addressing and loading of data is discussed in the synthesizer paragraphs of this instruction manual section.

1.8.6 Power Amplifier Control

The microcomputer controls the power amplifier and other transmit circuits via the PA enable switch (Q1607) and the keyed 9.4 V (k9.4 V) driver (Q1601, Q1602). When transmission occurs the loss of lock signal must be a logic low, indicating a synthesizer lock condition. The microcomputer must apply a logic low to U1609D, which in turn applies a logic high to Q1607 base. The output of Q1607 (collector) is a logic low that enables the power amplifier via the power control circuit. Pin 14 of the microcomputer goes high to enable keyed 9.4 V driver Q1601, Q1602. The output of the keyed 9.4 V driver:

- enables the antenna switch to route the power amplifier output to the antenna jack
- enables the modulation mute gate to apply transmit audio to the synthesizer for modulation
- enables the T/R switch to apply the synthesizer output to the intermediate power amplifier
- enables transmit data gate and filter input selector.

Note that the output of the PA enable switch, Q1607, is applied to pin 16 of the microcomputer. This allows the microcomputer to monitor the operation of the PA enable switch.

1.8.7 Trunked System Signals Processing Circuits

1.8.7.1 General Description

The trunked system signaling format requires the processing of both high and low speed data in both the transmit and receive modes. A filter input selector (U1604) controlled by the microcomputer works in conjunction with a low speed attenuator (Q1606), a low speed filter (U1606D, B, C), a high speed filter (U1606A; U1607A, B), a center slicer (U1603B; U1607C, D; U1608C), and a transmit data gate (U1608A) to provide the proper routing and shaping of these data signals.

1.8.7.2 Transmit Mode, High Speed Data

Microcomputer pin 27 applies a logic low to U1609A; the high output of U1609A enables filter input selector U1604 to select the high speed filter path. The high speed filter path begins at microcomputer pin 26 and goes to the high speed filter via U1604. (The low speed filter path begins at pin 26 and goes to the high speed filter via the low speed attenuator, the filter input selector, and the low speed filter.) The microcomputer applies high speed transmit data to the high speed filter via the high speed filter path. The high speed filter applies transmit data gate U1608A. A k9.4 V signal from the keyed 9.4 V driver enables the transmit data gate to apply the transmit data to the transmit audio circuits for modulation.

1.8.7.3 Transmit Mode, Low Speed Data

Microcomputer pin 27 applies a logic high to U1609A; the low output of U1609A enables filter input selector U1604 to select the low speed filter path. The microcomputer applies low speed transmit data to the low speed filter path. The keyed 9.4 V signal enables the transmit data gate to apply the low speed data to the transmit audio circuits.

1.8.7.4 Receive Mode, High Speed Data

Microcomputer pin 27 applies a logic low to U1609A; the high output of U1609A enables the filter input selector to select the high speed filter path. In the receive mode, the high speed filter path is from the detector to the high speed filter via the filter input selector (bypassing the low speed filter). The audio detector and buffer applies the detector output to the high speed filter via the high speed filter path. The high speed filter applies the detector output to the center slicer where it is applied to the microcomputer (pin 25) for decoding. The transmit data gate is not enabled.

1.8.7.5 Receive Mode, Low Speed Data

Microcomputer pin 27 applies a logic high to U1609A, the low output of U1609A enables filter input selector U1604 to select the low speed filter path. In the receive mode, the low speed filter path is from the audio detector and buffer to the high speed filter via the filter input selector and low speed filter. The detector output is applied to the microcomputer via the low speed filter path, the high speed filter and the center slicer. The microcomputer decodes the data signals that are present in the center slicer output. The transmit data gate is not enabled.

1.8.8 Receiver Audio Enable and Alert Tones

The microcomputer generates all of the alert tones used as audible indicators to the operator (except the failsoft tone). Tones are routed from pin 9 of microcomputer U1601 to the volume control and heard in the speaker. When the tones are generated, microcomputer pin 11 goes high driving the output of U1609D low. The low output of U1609D (REC MUTE) is applied to the receive mute gate which prevents the receive signal from being applied to the volume control while tones are being generated.

1.8.9 Watchdog Timer

The watchdog timer verifies microcomputer operation. When the microcomputer is operating, a pulse is regularly applied to the watchdog timer by microcomputer pin 30. This pulse restarts the timer. If the timer is not regularly restarted, the timer applies a reset signal to the microcomputer and the microcomputer begins a start-up routine (initialization).

1.8.10 Reset Delay

Upon initial power up, the reset delay circuit holds the RESET, pin 2, of the microcomputer low for a period of 220 microseconds. This assures proper initialization of microcomputer output ports.

1.8.11 Call Light Indicator

When pin 28 of the microcomputer goes low, the call light indicator is activated.

1.8.12 Volume Set Switch

When the volume set pushbutton is depressed, a low is applied to pin 20 of the microcomputer which causes it to apply a continuous tone to the speaker so the operator can adjust the volume.

1.8.13 External Alarm and Buffer Switch

Microcomputer pin 29 applies a logic low to U1609B when an external alarm is in progress. The high output of U1609B is applied to the external alarm buffer Q1610, and switch, Q1611.

speed data path. The detected signal is applied to the low speed filter via the filter input selector. The signal is filtered and shaped by the low speed filter and center slicer. The microcomputer attempts to decode the output of the center slicer. If a low speed handshake is detected, detected audio is routed to the speaker as previously described. If a low speed handshake signal is not detected, the microcomputer selects the high speed data path and programs the synthesizer for the control channel. When the control channel OSW is decoded, the microcomputer again attempts to program the synthesizer for the voice channel (if an OSW still contains the voice channel assignment).

2.3.4 After the voice channel is established, the detected audio is applied to the speaker until a disconnect word is received on the voice channel and decoded by the microcomputer. After disconnect, the microcomputer programs the synthesizer for the control channel.

2.4 INITIATING A CALL

2.4.1 A call is initiated when the PTT switch is closed, applying a logic high to microcomputer pin 17. The microcomputer keys the transmitter by activating the PA enable switch and keyed 9.4 V driver. The $\overline{\text{PA ENABLE}}$ signal is low and k9.4 V signal is high during transmit. The microcomputer programs the synthesizer for the control channel transmit frequency. Microcomputer pin 27 is low to select the high speed data path. Microcomputer pin 26 applies an inbound signal word (ISW) signal to the high speed filter via the filter input selector. The ISW is applied to the transmit audio circuits via the high speed filter and transmit data gate. The transmit audio circuits apply the ISW to the synthesizer to modulate the transmit rf signal. The microcomputer generates the ISW at a specific time that is determined by the timing of the OSW signal. This request ISW contains information about the mobile ID, fleet and subfleet to which the mobile is attached, and information about the purpose for which the channel is requested (group, system, or individual call). The length of the ISW transmission is 42 milliseconds.

2.4.2 After the ISW is transmitted, the microcomputer causes the $\overline{\text{PA ENABLE}}$ signal to go high and k9.4 V signal to go low and programs the synthesizer for the control channel receiver injection frequency. The detected signal is applied to microcomputer pin 25 via the high speed data path and center slicer. The microcomputer attempts to decode a received OSW that contains channel assignment information for the requested voice channel. If an OSW with channel assignment is not decoded, the microcomputer repeats the cycle of ISW transmission and OSW decoding at random intervals for about four seconds or until a channel assignment OSW is decoded.

NOTE

If, after the ISW is transmitted a random number of times over a four second period, a channel assignment OSW is not received, the radio remains in the receive mode on the control channel.

2.4.3 If a valid channel assignment OSW is decoded, the microcomputer programs the synthesizer for the assigned channel and attempts to detect the presence of a high speed handshake signal in the detector output signal. After the high speed handshake signal is detected, the microcomputer programs the synthesizer to transmit on the assigned channel. Microcomputer pin 26 applies an 1800 Hz tone to transmit audio circuits via the high speed data path and transmit data gate to modulate the transmitted signal for 80 milliseconds. Microcomputer pin 12 goes low to mute the microphone audio signal via U526A. The 1800 Hz tone is the acknowledge tone that is used to notify the system controller that the radio is on the assigned channel. When the system controller receives the acknowledge tone, the high speed handshake signal is no longer transmitted by the controller, and is replaced by the low speed handshake signal.

2.4.4 After the 1800 Hz acknowledge tone is transmitted, the following occurs:

- microcomputer pin 27 goes high to select the low speed data path
- microcomputer pin 12 goes high to enable the mic mute gate to apply microphone audio signals to the VCO and reference oscillator
- microcomputer pin 26 applies low speed connect tone to transmit audio circuits via the low speed data path.

2.4.5 The operator's voice signals are transmitted over the assigned channel until the PTT switch is released. When the PTT switch is released, microcomputer pin 12 goes high to activate microphone mute gate U526A. This mutes the microphone audio signal. Microcomputer pin 26 applies a 200 millesecond, 163 Hz tone to the transmit audio circuits via the low speed data path and transmit data gate. This 163 Hz tone is transmitted as the system disconnect tone. The microcomputer unkeys the transmitter and programs the synthesizer for the receive frequency of the assigned transmit/receive channel pair. The low speed receive data path is selected and the microcomputer decodes a low speed connect word. The radio remains on the receive channel until the low speed connect word is no longer decoded or until a disconnect word is received and decoded. A disconnect word is not transmitted over the receive channel by the system controller until there is an absence of mobile radio activity on the channel. After the disconnect word is decoded, the microcomputer programs the synthesizer for the control channel receive frequency.

2.4.6 If no channels are available when an ISW is transmitted, the system controller sends a busy OSW on the control channel. When the busy OSW is decoded, a busy tone is generated at microcomputer pin 9 and applied to the speaker until the microphone PTT button is released. The radio remains on the control channel receive frequency until a channel assignment OSW is received and decoded. When this OSW is decoded, the call back tones are applied to the speaker and the transmitter is keyed automatically for 3 seconds to hold the channel.

2.5 TRANSMIT ERROR DETECTION

During normal system operation, there is one valid transmit state and one valid receive state as defined by the states of pins 14, 15, 16 of the microcomputer. Refer to Table 1 for a summary of the valid states. If the logic states of pins 14, 15, and 16 do not correspond to one of the two valid states shown in Table 1 for more than one second, the microcomputer begins a transmit error routine. During this routine pin 15 is high and pin 14 is low. The synthesizer is programmed for the fourth control channel transmit frequency. No alert tones are routed to the speaker and the radio is inoperable. The microcomputer remains in the transmit error routine until the radio is turned off.

Table 1. Valid States

	Pin 16 TX MON	Pin 15 $\overline{\text{PA ENABLE}}$	Pin 14 k9.4 V CONTROL
Valid Transmit State	LOW	LOW	HIGH
Valid Receive State	HIGH	HIGH	LOW

2.6 FAILSOFT MODE (OPTIONAL)

2.6.1 If there is a failure of the system controller in a trunked radio system, the OSW's are no longer transmitted and the system stations operate as repeater stations. This is defined as the failsoft mode. Each repeater operates on a specific failsoft transmit/receive frequency pair. When OSW's are no longer decoded by the microcomputer, the radio begins searching for a control channel. The microcomputer attempts to decode a valid OSW on each control channel until all four channels are tried eight times. Radios programmed for the failsoft option program the synthesizer for the failsoft channel frequency after the eighth time. If a low speed handshake word is decoded by the microcomputer, the radio remains on the failsoft channel. The radio is unmuted and an audible beep is heard in the speaker every ten seconds. The audible beep is generated at the repeater station and modulates the repeater carrier. All transmissions on the failsoft channel are heard by the operator.

2.6.2 When the microphone PTT button is depressed, the microcomputer programs the synthesizer for the failsoft transmit frequency. $\overline{\text{PA ENABLE}}$ goes low and k9.4V goes high to key the transmitter. The receiver is muted and the transmitter remains keyed until the PTT button is released.

2.6.3 When the low speed handshake word is no longer decoded on the failsoft receive frequency, the radio begins the sequence to search for a control channel.

2.7 TRUNKING OPERATION SUMMARY

Table 2 lists the logic states of some the microcomputer pins during some typical radio operations.

Table 2. Operations Logic States

	Location and Signal Name					
Function	U1601-11 $\overline{\text{REC ENABLE}}$	U1601-14 k9.4 V	U1601-15 $\overline{\text{PA ENABLE}}$	U1601-27 LOW SPEED/ HIGH SPEED	U1601-12 $\overline{\text{MIC MUTE}}$	U1601-16 TX MON
Searching for a control channel	HIGH	LOW	HIGH	LOW	LOW	HIGH
Monitoring a control channel for assignment OSW	HIGH	LOW	HIGH	LOW	LOW	HIGH
Transmitting ISW on control channel	HIGH	HIGH	LOW	LOW	LOW	LOW
Receiving on voice channel ready for high speed handshake	HIGH	LOW	HIGH	LOW	LOW	HIGH
Receiving on voice channel ready for low speed handshake	HIGH	LOW	HIGH	HIGH	LOW	HIGH
Receiving voice and low speed handshake on voice channel	LOW	LOW	HIGH	HIGH	LOW	HIGH
Transmitting voice and connect tone on voice channel	HIGH	HIGH	LOW	HIGH	HIGH	LOW
Transmitting disconnect tone on voice channel	HIGH	HIGH	LOW	HIGH	LOW	LOW

3. UNIQUE CIRCUITS DESCRIPTION

(Refer to appropriate schematic diagrams in the Diagrams and Ancillary Equipment section)

3.1 AUDIO LIMITER

3.1.1 The audio limiter limits the audio power that is applied to the speaker to about 5 watts. This limiting protects the speaker and reduces distortion that may be caused by overdriving the speaker.

3.1.2 Audio amplifier U102 applies the audio signal to the speaker and to the audio limiter (Q102 and associated circuits). Diode CR155 rectifies the audio signal; the rectified signal is filtered by C141 resulting in a dc voltage at Q102 emitter. As the audio level increases, the voltage at Q102 emitter increases resulting in an increase in collector voltage. When the output power to the speaker exceeds 5 watts, Q102 collector voltage is high enough to forward bias diodes CR151 through 154. The low impedance path formed by C143 and forward biased diodes CR151 and CR152 attenuates the audio signal at the volume control. Reduced audio signal at the volume control results in reduced speaker output (approximately 5 watts).

3.2 POWER CONTROL CIRCUITS

3.2.1 Components that comprise the power control circuitry are located on the power amplifier board and the main board. Refer to the schematic diagrams for both of these boards (located in the back of this manual). Also refer to Figure 6 Simplified Schematic Diagram of Power Control Circuitry.

3.2.2 The power control circuitry generates the CONTROL VOLTAGE signal that controls the gain of the intermediate power amplifier and the first stage of the power amplifier module. The gain of these amplifiers is controlled to compensate for changes in supply voltage, final power amplifier current, and power amplifier temperature. The power control circuitry is only active when the radio is in the transmit mode ($\overline{\text{PA ENABLE}}$ low). A limiting circuit is included to limit the control voltage that is applied to the controlled power amplifier stages to 9.2 V. This limiting minimizes the possibility of excessive drive in the controlled power amplifier stages that may cause spurious emissions.

3.2.3 Generally, a change in the supply voltage (A+), final current to the power amplifier, and excessive temperature changes in the power amplifier result in a change in the emitter voltage and hence the emitter current of Q660. Specifically, the emitter current of Q660 can be affected by one or more of the following:

- a change in the current flow from the voltage supply (A+) through R600 to the amplifier circuits (change in final amplifier current). A change in final amplifier current changes the voltage applied to Q660 via R601.
- a change in supply voltage. This changes the voltage applied to Q660 via R600, R601, and R680.
- an increase in power amplifier temperature. As the temperature increases, the resistance of RT600 decreases. When the temperature is high enough, the voltage at the junction of RT600 and R603 is low enough to forward bias CR601. When CR601 is forward biased, the emitter voltage is reduced. An overheating condition can be simulated by shorting the TEST pads.
- excessive control voltage level. If the control voltage begins to exceed 8.8 volts, Zener diode VR663 begins to conduct. The base voltage of Q662 is increased, reducing Q662 collector voltage and increasing Q662 collector current. The increased conduction of Q662 results in reduced Q660 emitter current.

3.2.4 When Q660 emitter current decreases, the voltage applied to the base of Q661 is decreased. Q661 conducts less collector current, increasing the bias voltage applied to the base of PNP transistor Q663. Q663 conducts less emitter current and CONTROL VOLTAGE is decreased. When CONTROL VOLTAGE is decreased, the gain of the amplifier stages is reduced.

3.2.5 Similarly, if the Q660 emitter current is increased, the voltage applied to the base of Q661 is increased. Q661 conducts more collector current decreasing the bias voltage applied to the base of PNP transistor Q663. Q663 conducts more emitter current and CONTROL VOLTAGE is increased. When CONTROL VOLTAGE is increased, the gain of the amplifier stages is increased.

3.2.6 Transistor Q660 is biased for operation when $\overline{\text{PA ENABLE}}$ is low. POWER SET adjustment R669 is used to set the bias level of Q660; the bias level of Q660 determines the final output power of the power amplifier. Voltage regulator VR660 provides a stable reference voltage for the bias circuit to minimize the effect of any variations in the supply voltage on the bias level.

3.2.7 The primary function of the power control circuitry is to insure a constant final power amplifier current. This improves the reliability of the power amplifier devices when driving a mismatched load that results in a high VSWR. However, a significantly mismatched load can cause increased power variations over the operating range of the power amplifier (normal power variations over the operating range are less than 2 watts). Long antenna cables with multiple connectors represent a significant mismatch that may increase power variations (refer to the Maintenance section of this manual for important information about the use of cables and connectors when servicing the power amplifier circuits).

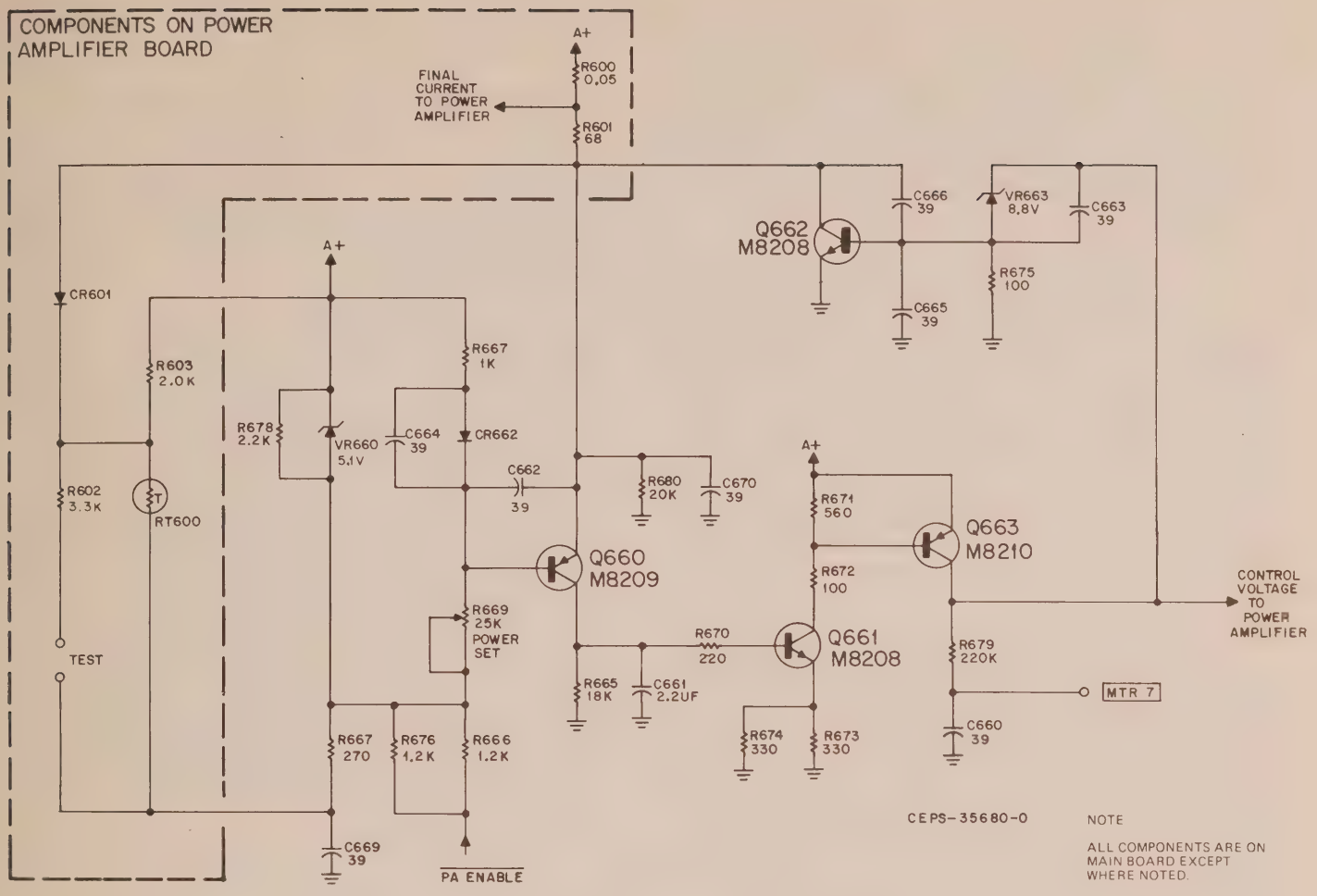

Figure 6. Simplified Schematic Diagram of Power Control Circuits

3.3 ANTENNA SWITCH

3.3.1 In the transmit mode, ANTENNA SWITCH ENABLE (J600-19) is approximately 1.6 volts; diodes CR700 and CR701 are forward biased. A series resonant circuit consisting of C700 and CR700 (an inductance at the operating frequency when forward biased) is a low impedance circuit that allows the power amplifier output to be applied to the antenna connector via C703. A filter consisting of CR701 (which represents an inductance at the operating frequency when forward biased) and C704 is in series resonance and attenuates transmit signals applied to the receive input circuits. A quarter-wave transmission line between CR700 and CR701 isolates the transmit and receive circuits. A quarter-wave shunt transmission line between U600 and C700 attenuates the even ordered harmonics of the power amplifier output.

3.3.2 In the receive mode, ANTENNA SWITCH ENABLE (J600-19) is low (0 volts); diodes CR700 and CR701 are off. CR700, L700, and C701 are parallel resonant and offer a high resistance path between the antenna connector and the power amplifier circuits. Signals from the antenna jack are routed to the receiver circuits via the low impedance path consisting of C703, C706, and two 50 ohm transmission lines. A filter consisting of CR701 (off), L703, and C704 is parallel resonant and represents a high impedance that does not attenuate the receive signal.

3.4 VOLTAGE FILTER AND REGULATOR CIRCUITS

3.4.1 U1502 is a 5 volt regulator integrated circuit that is the source of the 5 volt supply voltage required by some of the integrated circuit devices on the trunked command board.

3.4.2 The 9.6 volt regulator consists of integrated circuit U1501, and transistors Q1501 and Q1502. All of the 9.6 volt regulator components are located on the main board. This regulator is the source of the 9.6 volt supply voltage required by most of the circuits in the radio. During normal regulator operation, both inputs to operational amplifier U1501, pins 2 and 3, are at 5 V dc and the voltage at Q1501 collector is 9.6 V. Operation of 9.6 V regulation is described as follows.

3.4.2.1 R1502, R1503, and CR1501 monitor the dc voltage of the 9.6 V line and provide a temperature-stable voltage divider network which is fed back to U1501 and applied to its inverting input, pin 2. The non-inverting input is set to 5 V via VR1501 and R1501. When current increases, the 9.6 V line voltage begins to drop and causes the dc level at U1501-2 to decrease.

3.4.2.2 At this time the inputs of U1501 are no longer balanced and the dc output at pin 4 increases. This drives Q1502 and Q1501 further in order to supply enough current to correct the 9.6 V line. If an excessive amount of current is drawn from the 9.6 V line, the output voltage of U1501 will be limited by CR102 (the output cannot rise higher than 0.7 V above the 9.6 V line). This forces Q1502 and Q1501 off, and no current can be drawn. When the cause of the excessive current is corrected, a voltage of 5 V is applied to U1501-2, and U1501-1 then applies a bias voltage to activate Q1502, which resumes normal regulator operation.

3.4.3 The super filter consists of transistors Q1254 and Q1255 and associated components. This filter is used to provide an 8.6 volt supply voltage to the VCO circuits. The super filter output contains less noise and ripple than the 9.6 volt regulator output; this is required to prevent unwanted VCO modulation by noise and ripple. Transistor Q1254 is a series pass transistor; Q1255 is an error amplifier that controls the conduction of Q1254 removing ripple and noise present on the VCO supply line. Additional filtering is provided by capacitors C1282, C1283, and C1286 through C1288.

3.5 PLL INTEGRATED CIRCUIT

3.5.1 Refer to Figure 3 Synthesizer Block Diagram in this section and the trunked command board schematic diagram. Before frequency synthesis can begin, the microcomputer must load frequency divider information into the PLL integrated circuit. The PLL integrated circuit contains three programmable dividers ($\div$A, $\div$N, $\div$R). The values of A, N, and R are stored in eight four-bit latches (L0-L7). The microcomputer addresses the PLL integrated circuit latches via three address lines (A0-A2). The microcomputer applies 4 bits of data into the latches via four parallel data lines (D0-D3).

3.5.2 Prior to loading the latches, microcomputer pin 32 goes low to turn off Q1608. This insures that the SYN STROBE line is not held low by Q1608 and CR1605. The microcomputer loads all eight latches one at a time by performing the following cycle eight times. The microcomputer applies a latch address to U1002-9, -10, -11. The data to be stored in the latch is applied to U1002-1, -2, -19, -20. The SYN STROBE signal (generated at U1601-40) is a positive-going pulse that is applied to U1002-12. On the falling edge of the pulse, the data on the data lines (D0-D3) is stored in the PLL integrated circuit latch addressed by the address lines (A0-A2).

3.5.3 The latches are loaded with data to provide the following:

- 6.25 kHz at $\div$R counter output when the reference oscillator signal is applied at U1002-7.
- 6.25 kHz at $\div$N counter output when VCO is operating at a frequency that is one-half the frequency of the desired receive first injection or transmit frequency.

3.5.4 During frequency synthesis, the $\div$A and $\div$N counters begin counting down from the programmed values (A and N respectively) at the same time. The MOD CON line (U1002-14) is low so the $\div$127/128 prescaler divides by 128. Therefore, the effect of the prescaler (U1000) is to divide the VCO output by 128 and apply it to U1002-3. When the $\div$A counter completes counting down, the control logic sets the MOD CON line high and the $\div$N counter continues counting. While the MOD CON line is high, the $\div$127/128 prescaler divides by 127 until the $\div$N counter counts down from the programmed value of N. After the $\div$N counter completes counting down, the counters are set back to their programmed values, the MOD CON line is set low, and the counters begin counting down again. The effect of the prescaler and $\div$A, $\div$N counters is to divide the VCO frequency by a number, N_T, where,

$$N_T = 128 \times A + 127 \times (N - A)$$
$$N_T = 127 \times N + A$$

3.5.5 The output of the $\div$N counter is equal to:

$$\frac{f_{VCO}}{127 \times N + A}$$

where f_{VCO} is the output frequency of the VCO.

When the phase-locked loop is locked:

$$\frac{f_{VCO}}{127 \times N + A} = 6.25\ \text{kHz} = \frac{f_{VCO}}{N_T}$$

The reference oscillator frequency is 14.4 MHz and the output of the $\div$R counter must be 6.25 kHz, therefore:

$$R = \frac{14.4\ \text{MHz}}{6.25\ \text{kHz}}$$
$$= 2304_{10}$$
$$= 10010000\ 0000_2$$

The value of R in base 2 is stored in latches L5, L6, L7 as shown in Table 3.

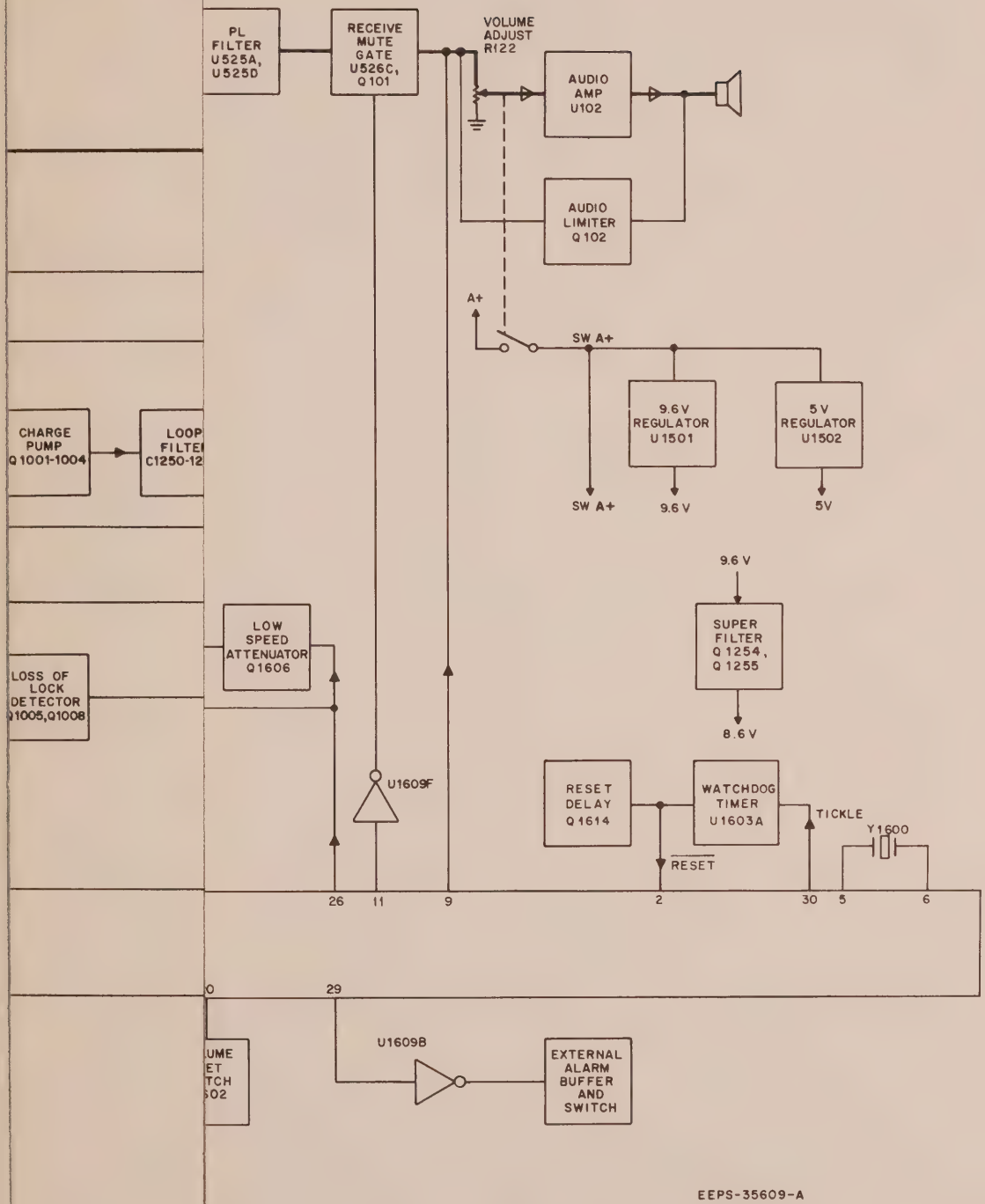

Figure 5. Radio Block Diagram

3.4.2.1 R1502, R1503, and CR1501 monitor the dc voltage of the 9.6 V line and provide a temperature-stable voltage divider network which is fed back to U1501 and applied to its inverting input, pin 2. The non-inverting input is set to 5 V via VR1501 and R1501. When current increases, the 9.6 V line voltage begins to drop and causes the dc level at U1501-2 to decrease.

3.4.2.2 At this time the inputs of U1501 are no longer balanced and the dc output at pin 4 increases. This drives Q1502 and Q1501 further in order to supply enough current to correct the 9.6 V line. If an excessive amount of current is drawn from the 9.6 V line, the output voltage of U1501 will be limited by CR102 (the output cannot rise higher than 0.7 V above the 9.6 V line). This forces Q1502 and Q1501 off, and no current can be drawn. When the cause of the excessive current is corrected, a voltage of 5 V is applied to U1501-2, and U1501-1 then applies a bias voltage to activate Q1502, which resumes normal regulator operation.

3.4.3 The super filter consists of transistors Q1254 and Q1255 and associated components. This filter is used to provide an 8.6 volt supply voltage to the VCO circuits. The super filter output contains less noise and ripple than the 9.6 volt regulator output; this is required to prevent unwanted VCO modulation by noise and ripple. Transistor Q1254 is a series pass transistor; Q1255 is an error amplifier that controls the conduction of Q1254 removing ripple and noise present on the VCO supply line. Additional filtering is provided by capacitors C1282, C1283, and C1286 through C1288.

3.5 PLL INTEGRATED CIRCUIT

3.5.1 Refer to Figure 3 Synthesizer Block Diagram in this section and the trunked command board schematic diagram. Before frequency synthesis can begin, the microcomputer must load frequency divider information into the PLL integrated circuit. The PLL integrated circuit contains three programmable dividers ($\div$A, $\div$N, $\div$R). The values of A, N, and R are stored in eight four-bit latches (L0-L7). The microcomputer addresses the PLL integrated circuit latches via three address lines (A0-A2). The microcomputer applies 4 bits of data into the latches via four parallel data lines (D0-D3).

3.5.2 Prior to loading the latches, microcomputer pin 32 goes low to turn off Q1608. This insures that the SYN STROBE line is not held low by Q1608 and CR1605. The microcomputer loads all eight latches one at a time by performing the following cycle eight times. The microcomputer applies a latch address to U1002-9, -10, -11. The data to be stored in the latch is applied to U1002-1, -2, -19, -20. The SYN STROBE signal (generated at U1601-40) is a positive-going pulse that is applied to U1002-12. On the falling edge of the pulse, the data on the data lines (D0-D3) is stored in the PLL integrated circuit latch addressed by the address lines (A0-A2).

3.5.3 The latches are loaded with data to provide the following:

- 6.25 kHz at $\div$R counter output when the reference oscillator signal is applied at U1002-7.
- 6.25 kHz at $\div$N counter output when VCO is operating at a frequency that is one-half the frequency of the desired receive first injection or transmit frequency.

3.5.4 During frequency synthesis, the $\div$A and $\div$N counters begin counting down from the programmed values (A and N respectively) at the same time. The MOD CON line (U1002-14) is low so the $\div$127/128 prescaler divides by 128. Therefore, the effect of the prescaler (U1000) is to divide the VCO output by 128 and apply it to U1002-3. When the $\div$A counter completes counting down, the control logic sets the MOD CON line high and the $\div$N counter continues counting. While the MOD CON line is high, the $\div$127/128 prescaler divides by 127 until the $\div$N counter counts down from the programmed value of N. After the $\div$N counter completes counting down, the counters are set back to their programmed values, the MOD CON line is set low, and the counters begin counting down again. The effect of the prescaler and $\div$A, $\div$N counters is to divide the VCO frequency by a number, N_T, where,

$$N_T = 128 \times A + 127 \times (N - A)$$
$$N_T = 127 \times N + A$$

3.5.5 The output of the $\div$N counter is equal to:

$$\frac{f_{VCO}}{127 \times N + A}$$

where f_{VCO} is the output frequency of the VCO.

When the phase-locked loop is locked:

$$\frac{f_{VCO}}{127 \times N + A} = 6.25\,\text{kHz} = \frac{f_{VCO}}{N_T}$$

The reference oscillator frequency is 14.4 MHz and the output of the $\div$R counter must be 6.25 kHz, therefore:

$$R = \frac{14.4\,\text{MHz}}{6.25\,\text{kHz}}$$
$$= 2304_{10}$$
$$= 10010000\,0000_2$$

The value of R in base 2 is stored in latches L5, L6, L7 as shown in Table 3.

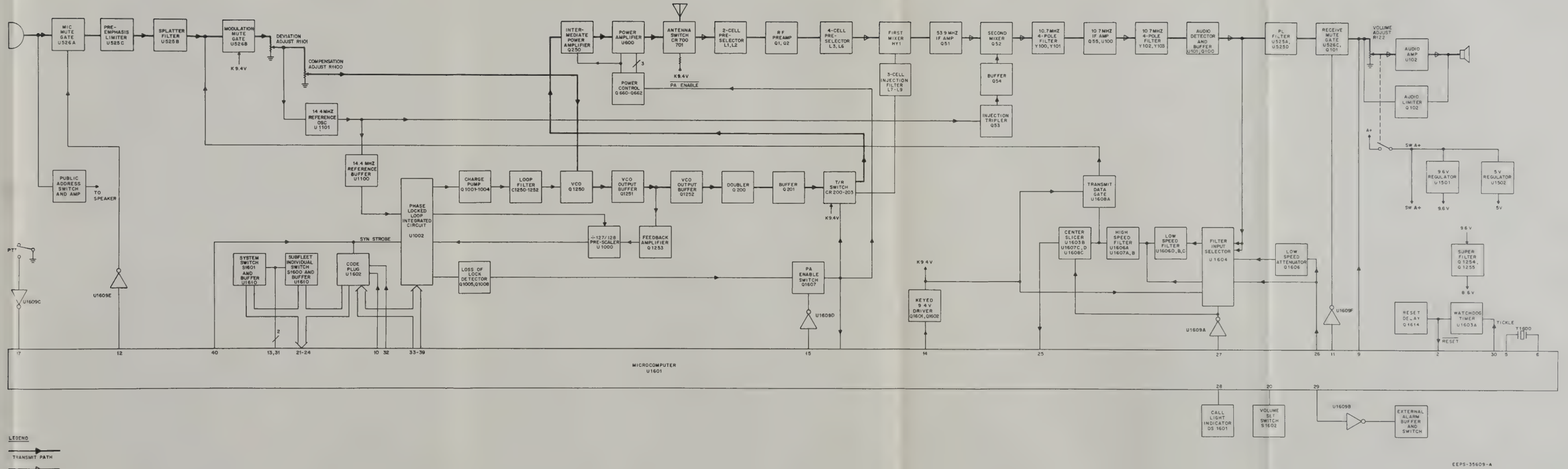

Figure 5. Radio Block Diagram

Table 3. Example of Data in Latches L5-L7

	Address			Data			
Latch	A_2	A_1	A_0	D_3	D_2	D_1	D_0
L5	1	0	1	0	0	0	0
L6	1	1	0	0	0	0	0
L7	1	1	1	1	0	0	1

3.5.6 The values of A and N are dependent on the desired VCO frequency, and the VCO frequency is dependent on the transmit frequency or receive frequency as shown:

$$f_{VCO} = \frac{f_T}{2} \text{ or } f_{VCO} = \frac{f_R - 53.9\,MHz}{2}$$

where f_T = transmit frequency
f_R = receive frequency

The values of N and A can be determined from the desired frequency of the VCO where:

$$N = \text{integer part of } \frac{N_T}{127}$$

$$A = \text{remainder of } \frac{N_T}{127}$$

For example, if the receive frequency is 851.0125 MHz,

$$f_{VCO} = \frac{851.0125\,MHz - 53.9\,MHz}{2}$$

$$f_{VCO} = 398.55625\,MHz$$

$$\text{then } N_T = \frac{398.55625\,MHz}{6.25\,kHz} = 63769, \text{ and}$$

502 integer part of quotient
127|63769
635
269
254
15 remainder

$N = 502_{10} = 0111110110_2$
$A = 15_{10} = 0001111_2$

The binary values of A and N are stored in their latches as shown in Tables 4 and 5.

Table 4. Example of Latched Value of A

	Address			Data			
Latch	A_2	A_1	A_0	D_3	D_2	D_1	D_0
L0	0	0	0	1	1	1	1
L1	0	0	1	*	0	0	0

* = don't care

Table 5. Example of Latched Value of N

	Address			Data			
Latch	A_2	A_1	A_0	D_3	D_2	D_1	D_0
L2	0	1	0	0	1	1	0
L3	0	1	1	1	1	1	1
L4	1	0	0	*	*	0	1

* don't care

3.5.7 The 6.25 kHz outputs of the ÷A and ÷N counters are applied to phase detector A; the output of phase detector A is applied to phase detector B. There are two output signals for phase detector B (ΦR and ΦV). Signals ΦR and ΦV consist of pulses with a pulse width that is dependent on the phase error for the two signals at phase detector A. These pulses are applied to the charge pump and are used to correct the VCO frequency.

3.5.8 When the synthesizer is locked, U1002-13 applies a high level signal with very narrow negative-going pulses to the loss of lock detector.

3.6 CHARGE PUMP

The charge pump consists of transistors Q1001 through Q1004. The ΦV signal from the PLL integrated circuit is applied to Q1002, and the ΦR signal is applied to Q1001. When the synthesizer is locked, both signals consist of a pulse train with a period of 160 microseconds and negative-going pulses of 200 nanoseconds in duration. The ΦV pulse results in an increase in conduction at Q1004 and the ΦR pulse results in a increase in conduction at Q1003. Increased conduction of Q1004 discharges capacitor C1250 in the loop filter; increased conduction of Q1003 charges C1250. The output of the charge pump is the sum of the collector currents of Q1003 and Q1004; and the net current is proportional to the pulse width difference between ΦV and ΦR. When the synthesizer is locked, the ΦV and ΦR pulses have the same pulse width and phase. This results in little or no change in the sum of the collector currents of Q1003, Q1004. Following synthesizer reprogramming a phase error is detected by the PLL integrated circuit, causing the duration of each of the ΦR and ΦV pulses to be different, resulting in a change in the sum of collector currents of Q1003, Q1004. Therefore, the charge pump applies a series of summed current pulses to the loop filter to charge or discharge capacitor C1250. The duration and polarity of the summed current pulses is proportional to the detected phase error.

3.7 LOOP FILTER

The loop filter consists of capacitors C1250 through C1252 and resistors R1250 and R1251. The loop filter is a low pass filter that is used to attenuate noise and reject the loop reference frequency (6.25 kHz). These unwanted signals are attenuated so that they do not modulate the VCO. The filter is an integrator circuit for the output of the charge pump. Current pulses from the charge pump charge or discharge

capacitor C1250. The voltage across the series combination of R1250 and C1250 is the steering line voltage that is used to control the VCO frequency.

3.8 VOLTAGE CONTROLLED OSCILLATOR (VCO)

3.8.1 The VCO consists of field effect transistor Q1250 and associated components in a Colpitts oscillator configuration. Helical resonator L1252 is the primary frequency determining element in the VCO. Varactor diodes are used to control the oscillator frequency and to modulate the oscillator.

3.8.2 The steering line voltage of the loop filter is applied to varactor diodes CR1251 and CR1250. A decrease in steering line voltage increases the capacitance of the varactors resulting in a decrease in VCO frequency. Similarly an increase in steering line voltage increases the VCO frequency.

3.8.3 The VCO is directly modulated by the transmit audio signal. Resistors R1254 and R1255 reduce the audio signal level that is applied to the VCO circuits via J700-6. This resistor combination also attenuates any stray unwanted signals. The attenuated audio signal is applied to varactor diode CR1253 to modulate the VCO.

3.8.4 At the VCO frequency, L1254 is a very high impedance and capacitor C1263 is a very low impedance. An rf voltage appears across L1254 and is rectified by diode CR1252. Resistor R1252 and capacitors C1261 and C1262 filter the dc voltage and any low frequency noise. This dc voltage becomes the FET gate bias voltage which acts on the VCO as an automatic gain control (AGC) voltage.

3.9 LOSS OF LOCK DETECTOR

3.9.1 When the synthesizer is locked, a high logic level with a negative-going pulse train of very narrow pulses is present at U1002-13. The negative going pulses forward bias diode CR1001 and start to discharge capacitor C1021. The pulses are so narrow that the charge on the capacitor remains high enough to forward bias the base-emitter junction of Q1005. The low collector voltage at Q1005 collector is applied to the base of Q1006 via voltage divider R1016, R1018. Q1006 is biased off and the collector voltage of Q1006 is high enough to turn on transistors Q1007, Q1008. LOSS OF LOCK signal at the collector of Q1008 is low to indicate a lock condition.

3.9.2 When the synthesizer is out-of-lock, U1002-13 output becomes a pulsating dc signal with an average dc level that varies between 0.5 and 3.0 volts. This signal discharges capacitor C1021 enough to turn off Q1005. Q1005 collector voltage increases to forward bias the base-emitter junction of Q1006. Q1006 collector voltage goes low, reducing the bias to Q1007, Q1008. The collector of Q1008 goes high to indicate an out-of-lock condition.

3.10 DOUBLER, BUFFER, AND TRANSMIT/RECEIVE (T/R) SWITCH

3.10.1 The doubler circuit consists of transistor Q200 and associated components including some microstrip inductors. The microstrip inductors consist of circuit board foil patterns designed to provide a specific inductance. The transistor is soldered directly to specially slotted holes in the main board circuit board. These specially slotted holes minimize lead inductance at rf frequencies. Capacitor C202 and a microstrip inductor (from C202 to ground) form a series resonant circuit at 800 MHz which improves doubler efficiency. Another series resonant circuit (at 400 MHz) consisting of L202 and C203 is part of the doubler collector circuit and attentuates 400 MHz signals present at the doubler output. This circuit doubles the frequency of an input signal in the 400 MHz range and amplifies it typically from 10 mW to 40 mW.

3.10.2 The buffer consists of an amplifier (Q201) with power leveling circuitry to ensure relatively constant rf output power. As the input power to the buffer increases, collector current drawn through the parallel combination of R214, R215 increases and the collector voltage decreases. When the collector voltage decreases, gain decreases and power output remains relatively constant. Similarly, when input power is decreased, the decreased collector current results in increased gain in the buffer. This power leveling action allows an output level of about 150 mW.

3.10.3 The T/R switch routes the doubled VCO output to the intermediate power amplifier in the transmit mode, or to the receiver first mixer injection circuits in the receive mode. In the transmit mode, the PA ENABLE line is low, and the k9.4V signal is high. Diodes CR201, CR202, and CR203 are forward biased; diode CR200 is reverse biased. The reverse biased diode offers a high impedance to the doubled VCO signal; the forward biased diodes offer a low impedance path to the signal. The doubled VCO signal is routed to the intermediate power amplifier from buffer Q201 via C207, CR201, CR202, C208, and R208.

3.10.4 In the receive mode, the PA ENABLE line is high and the k9.4V signal is low. Diodes CR201, CR202, and CR203 are reverse biased; diode CR200 is forward biased. The doubled VCO output is routed to the 3-cell injection filter for the receiver first mixer from buffer Q201 via C207, CR200, C209, and R211. C212, L205, and CR201 comprise an antiresonant network that provides a minimum of 35 dB of attenuation between the receive injection signal path and the signal path to the intermediate power amplifier.

3.11 PA ENABLE SWITCH

When the radio is in the transmit mode, U1601-15 applies a logic low to U1609D. The output of U1609D goes high; this high is applied to the base of PA enable switch Q1607. The LOSS OF LOCK signal is applied to the emitter of Q1607; if the LOSS OF LOCK is low, the

emitter-base junction of Q1607 is forward biased and the collector voltage (PA ENABLE) is low. When the LOSS OF LOCK signal is high (indicating loss of lock) and/or when the radio is in the receive mode the PA ENABLE signal is high.

3.12 KEYED 9.4 V DRIVER

When the radio is in the transmit mode, U1601-14 is high. Q1601 and Q1602 are both activated, and the collector voltage of Q1602 is 9.4 V. This voltage is applied to the modulation mute gate, the antenna switch, and the T/R switch. When the radio is in the receive mode, U1601-14 is low and Q1602 collector voltage is low.

3.13 DATA FILTERS

3.13.1 General

The filter section is comprised of the following major functional elements:

- Low-speed (low pass) seven-pole Butterworth filter with a corner frequency of 200 Hz.
- High-speed (low pass) seven-pole Bessel filter with a corner frequency of 2050 Hz.
- A filter input selector (U1604) which acts as a two-pole-four position switch.
- Transmit data gate U1608A utilized to implement data and audio routing.
- A low-speed attenuator (Q1606), to obtain a 3:1 deviation ratio between high speed and low speed data.
- Data recovery center slicer circuitry.

3.13.2 Low Speed Filter

3.13.2.1 The low speed filter is a seven-pole, low pass Butterworth filter with a corner frequency of 200 Hz that is used to:

- Remove from the received data any high frequency noise that may have been introduced by the transmission process.
- Remove any voice energy from the low speed data. In this mode it is called a "voice blocking filter" since it prevents any voice energy from causing any distortion to the receive data.
- Attenuate harmonics of the subaudible connect tone and disconnect tone when they are transmitted. This prevents a listening mobile from hearing any objectionable low frequency tones.

3.13.2.2 Operational amplifiers U1606D, B, and C are used as the active elements in the filter with resistors R1632, R1635, and R1638 providing temperature compensation.

3.13.3 High Speed Filter

3.13.3.1 The high speed filter is a seven-pole, low pass Bessel filter with a corner frequency of 2050 Hz that is used to:

- Remove from the received data any high frequency noise that may have been introduced by the transmission process.
- Serve as a splatter filter during transmission of high speed data to attenuate any harmonics whose frequencies are greater than 2050 Hz.

3.13.3.2 Operational amplifiers U1606A, U1607A, and U1607B are used as the active elements in the filter with resistors R1642, R1645, and R1648 providing temperature compensation.

3.13.4 Filter Input Selector (U1604)

This device is used to route receive and transmit data through the proper filter at the proper time as directed by the microcomputer. The filter input selector is the equivalent of a two-pole/four-position switch. The selector state is controlled by the A and B inputs on pins 10 and 9, respectively, according to Table 6, and Figure 7.

Table 6. Filter Input Selector Truth Table

A	B	Mode	Function
LOW	LOW	0	Receive Low Speed Data
HIGH	LOW	1	Receive High Speed Data
LOW	HIGH	2	Transmit Low Speed Data
HIGH	HIGH	3	Transmit High Speed Data

NOTE: The "LOW" is a voltage less than 1 volt and the "HIGH" is a voltage greater than 9 volts.

3.13.5 Transmit Data Gate (U1608A)

U1608A controls the passage of filtered transmitted high speed (3600 baud) or low speed (150-300 baud) data to the modulator. When k9.4 V signal is high, the transmit data gate applies the output of the high speed filter to the transmit modulation mute gate.

3.13.6 Low Speed Attenuator

In order to provide a 3:1 deviation ratio between high speed data (i.e. ISW) and low speed data (i.e. subaudible connect tone) NPN transistor Q1606 is configured as an emitter follower and attenuator. The biasing and input resistors R1626, R1628, and R1627 are used to reduce the 5 volt p-p square wave input to approximately 1 volt p-p. Since the voltage gain through an emitter follower is typically 0.99, almost all of the signal at the base of Q1606 is also at the emitter, across R1628. The impedance transformation also typical of emitter followers provides a low impedance source to drive the filter stages.

3.13.7 Signal Summary

The data signals and signaling tones that are routed through the data filters are shown in Table 7.

3.14 CENTER SLICER

3.14.1 The center slicer converts the analog filtered data from the receiver into a square digital bit stream that is fed to the microcomputer for decoding.

3.14.2 The conversion process would be relatively simple if all the received data bits had the same amplitude and they did not contain any average dc voltage. See Figure 8A as an example. If this data is fed to U1603B-5 (see Figure 9) while a dc source equal to half of the bit voltage is fed to U1603B-4 the comparator provides, at U1603B-2 a digital output that is the equivalent of the receive analog data.

3.14.3 If the data bits have different amplitudes as could happen under noisy conditions or if the data contains a dc step as could happen while changing from a frequency channel to an off frequency channel (see Figure 8B), then the recovery process is not a simple one.

3.14.4 Referring to Figure 8B again, it can be seen that if the comparator threshold point is tied to a fixed voltage, this voltage can occur at any point in a fluctuating bit stream, resulting in missing bits and/or skewed data (1's wider or narrower than 0's).

Table 7. Data Signals and Signaling Tones

Signal Name	Radio Mode	Speed	Frequency or Rate	Channel
Low speed handshake connect word	Receive	Low	150 baud	Voice
Low speed disconnect word	Receive	Low	300 baud	Voice
Background data word	Receive	High	3600 baud	Control
Outbound signaling word (OSW)	Receive	High	3600 baud	Control
High speed handshake word	Receive	High	3600 baud	Voice
Subaudible connect tone	Transmit	Low	76.6 to 138.5 Hz	Voice
Subaudible disconnect tone	Transmit	Low	163 Hz	Voice
Inbound signaling word (ISW)	Transmit	High	3600 baud	Control
Acknowledge tone	Transmit	High	1800 Hz	Voice

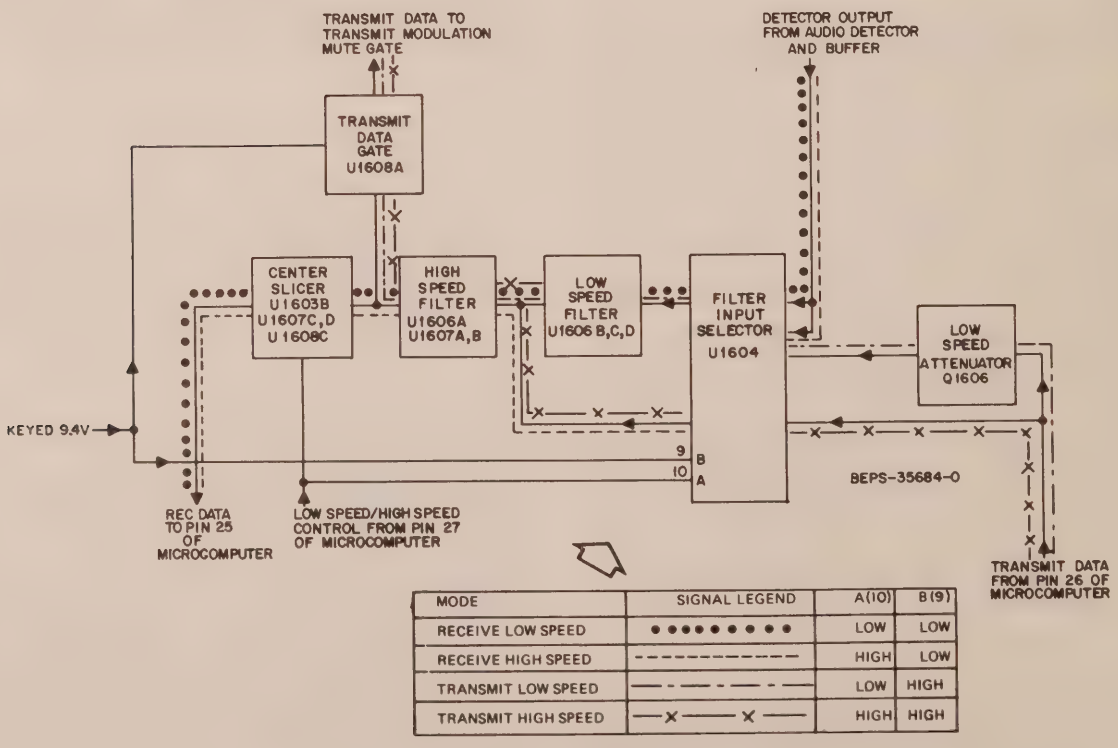

Figure 7. Data Paths

3.14.5 The center slicer compensates for any shift in the average dc value for any variations in data amplitude by shifting the comparator reference input so that it lies exactly halfway between the serial data bit peaks.

3.14.6 U1607D and CR1601 in Figure 9 form an ideal diode which, along with C1627, form a positive peak detector. C1627 charges to the maximum peak value of the data. Likewise a negative peak detector is formed by U1607C, CR1602 and capacitor C1626.

3.14.7 Resistors R1651 and R1652 form a summing network. The voltage at the junction of R1651, R1652 is the sum of the two peak voltages divided by two. This voltage is the reference voltage and varies with the data amplitude and dc voltage present. The reference voltage is applied to U1603-4 and the receive data is applied to U1603-5. The recovered digital bit stream appears at U1603-2 as shown in Figure 8C.

3.14.8 Also included in the center slicer is transmission gate U1608C and resistor R1650. These two

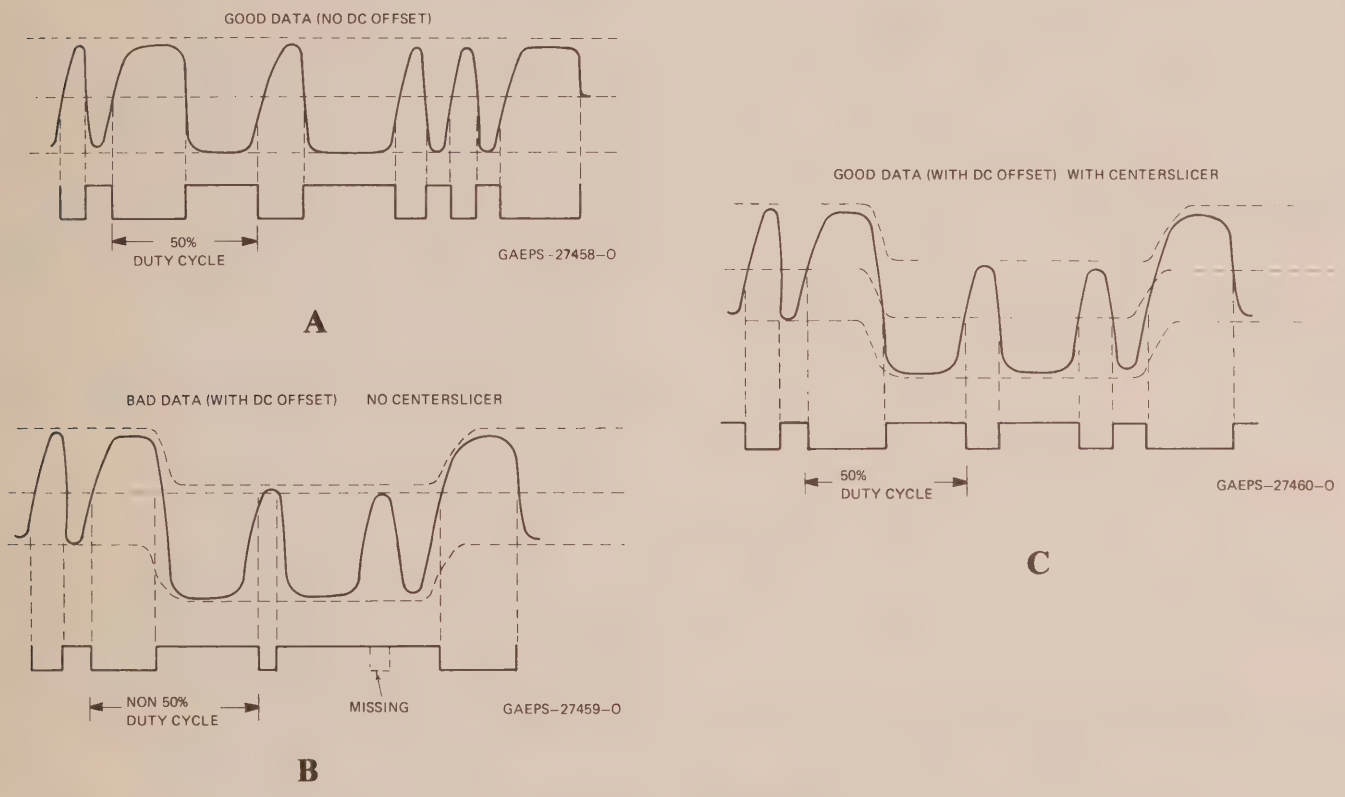

Figure 8. Data Recovery Example

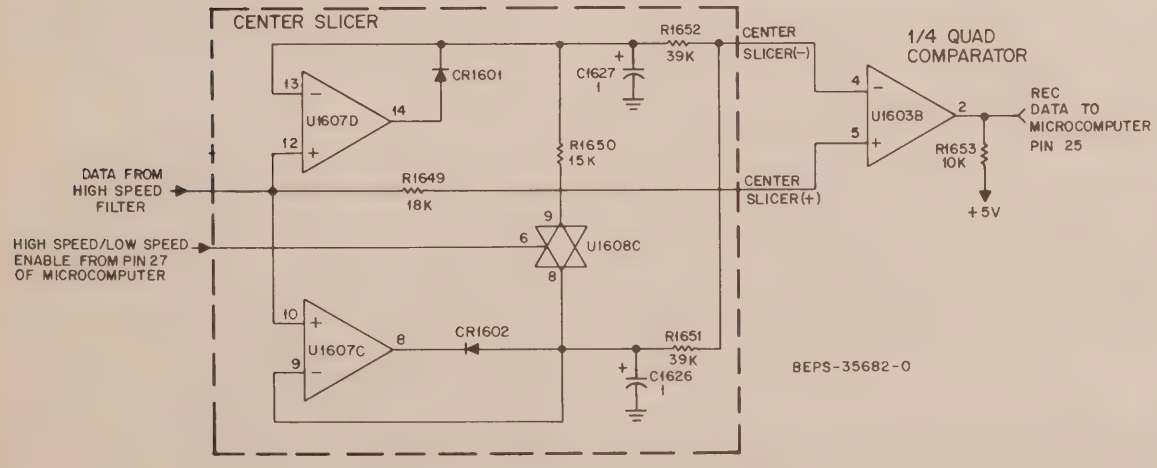

Figure 9. Center Slicer Circuit

components are used to change the time constant of the peak detectors. In order to respond to the high speed data without "over integrating" the pulses, the time constant is made shorter in modes 1 and 3 by putting a high signal (greater than 9 volts) on U1608-6. The time constant is made shorter so that the reference voltage generated by the center slicer more closely represents the voltage midway between successive data bits. If the time constant were too long, the reference voltage would be following data that had already passed through the circuit. Therefore, the transmission gate is on in modes 1 and 3 and off in modes 0 and 2.

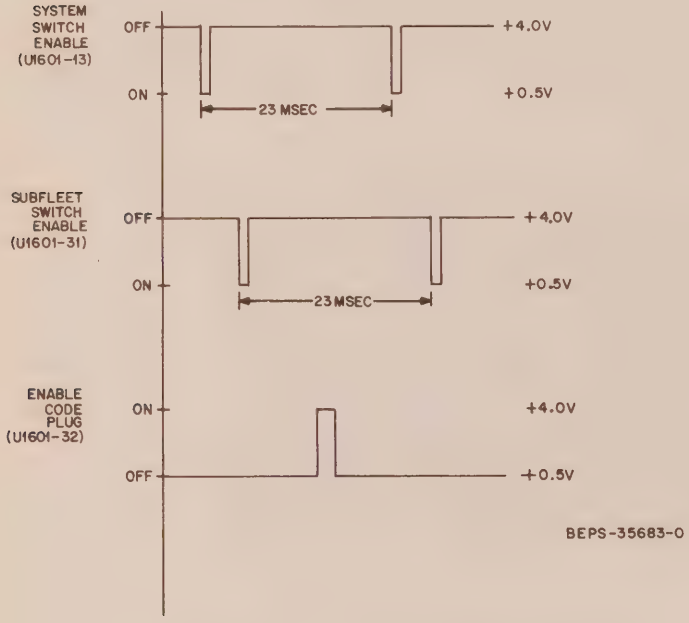

Figure 10. Timing Diagram

3.15 CODE PLUG, SYSTEM SWITCH, AND SUBFLEET/INDIVIDUAL SWITCH

3.15.1 The code plug is a PROM that contains identification and channel information for the radio. Code plug memory locations are addressed by pins 10 and 33-40 of the microcomputer. Four-bit data words from the PROM memory locations can be applied by code plug pins 9-12 to microcomputer pins 21-24. The subfleet/individual switch and system switch are multiple position rotary switches whose outputs consist of a 4-bit code that is dependent on the switch position. The output of both switches can be applied to microcomputer pins 21-24 via switch buffer U1610. The code plug outputs are only applied to the microcomputer when the PROM is enabled. The switch outputs are only applied to the microcomputer when the appropriate switch buffer section is enabled. The sequences required for enabling the PROM and the switch buffers are described below.

3.15.2 When the microcomputer is ready to enable the code plug, U1601-13 and -31 are high to disable all of the buffers in switch buffer U1610. The microcomputer applies the memory location address to pins 1-7, 14, 15 of the code plug. Microcomputer pin 32 applies a high to the base of Q1608; the collector of Q1608 goes low. This low is applied to U1602-13 to enable the code plug; the low is also applied to Q1609 which is activated and applies 5 V to the PROM supply voltage input. Data from the addressed memory location is applied from the PROM to the microcomputer. Q1608 collector also applies a low to the SYN STROBE line via diode CR1605 to prevent the synthesizer from being strobed when U1601-40 is addressing the PROM. Diode CR1604 prevents the low collector voltage from being applied to PROM input A7. The above sequence is repeated for each memory location to be read.

3.15.3 When U1601-13 is low, the buffers connected to the system switch output pins are enabled and the four data bits from the switch are applied to the microcomputer. When U1601-31 is low, the buffers connected to the subfleet/individual switch output pins are enabled and the four data bits from the switch are applied to the microcomputer. Both switches are read during each OSW word frame period (or every 23-1/3 milliseconds). The output signals of U1601-13 and U1601-31 are negative-going pulse trains with a period of 23-1/3 milliseconds as shown in Figure 10. The microcomputer can address and read the PROM when U1601-13 and U1601-31 are high as shown in Figure 10.

3.16 RESET DELAY CIRCUIT

When power is first applied to the radio, C1643 is not charged. C1643 not being charged applies a forward bias to Q1614 which then turns on. Q1614 holds the reset line, pin 2 of the microcomputer, low while C1643 is charging. When C1643 is charged (a period of about 220 microseconds) it turns off Q1614, the reset line goes high, and the microcomputer can begin operation.

3.17 WATCHDOG TIMER

3.17.1 The watchdog timer forces the microcomputer to reset if there is a lack of microcomputer activity for a period exceeding the initial reset circuit delay.

3.17.2 After the microcomputer begins operation, capacitor C1603 begins to discharge and the voltage at U1603-6 begins to rise. When the microcomputer is operating properly, U1601-30 applies positve-going pulses to the gate of Q1603 every 23 milliseconds. Each pulse activates Q1603 to charge C1603 thereby lowering the voltage at U1603-6. If the microcomputer is not operating properly and as a result the pulses are not applied by U1601-30 approximately every 23 milliseconds, C1603 continues to discharge causing the voltage at U1603-6 to rise. When the voltage at U1603-6 is greater than the reference voltage at U1603-7, U1603-1 goes low and the microcomputer is reset.

4. MICROCOMPUTER SIGNALS

Pin 1 GROUND.

Pin 2 $\overline{\text{RESET}}$ — A low applied to this pin for a minimum of 100 ms interrupts operating software and resets the microcomputer. This pin must be high for the microcomputer to run operating software.

Pin 3 $\overline{\text{TRUNK TEST}}$ — A low applied for 1 second after initialization causes the microcomputer to execute a self-test routine.

Pin 4 SUPPLY VOLTAGE (5 V)

Pins 5, 6 EXTAL, XTAL — connecting pins for crystal used to set clock frequency.

Pins 7, 8 SUPPLY VOLTAGE (5 V)

Pin 9 ALERT TONES — pin used by microcomputer to apply signaling or operating tones to the radio.

Pin 10 CODE PLUG ADDRESS LINE A8 — Always low in radios programmed for use in 3 or less systems. High when addressing the code plug with the system switch selecting any system beyond the third system.

Pin 11 $\overline{\text{REC ENABLE}}$ — low to enable receive audio to be routed to the speaker.

Pin 12 MICROPHONE MUTE — low to enable microphone audio to be applied to the pre-emphasis limiter.

Pin 13 SYSTEM SWITCH ENABLE — low to enable system switch output to be applied to the microcomputer.

Pin 14 KEYED 9.4 V CONTROL — high when radio is in transmit mode.

Pin 15 $\overline{\text{PA ENABLE}}$ — low to enable the power amplifier.

Pin 16 TRANSMIT MONITOR — output of PA enable circuit is applied to this pin. Used by microcomputer to detect invalid transmit or receive conditions.

Pin 17 PTT — a high is applied to this pin when the radio is keyed by the microphone or handset.

Pin 18 $\overline{\text{PRIVATE}}$ — a low is applied to this pin if the optional Private button is depressed.

Pin 19 $\overline{\text{INTERNAL CODE PLUG SELECT}}$ — a low applied during power-up to this pin initiates test mode using internal code plug.

Pin 20 $\overline{\text{VOLUME SET}}$ or $\overline{\text{TELEPHONE}}$ — a low is applied to this pin if the optional Volume Set or Telephone pushbutton is depressed.

Pins 21-24 CODE PLUG AND ROTARY SWITCH INPUT — the output of code plug PROM, subfleet switch, and system switch is applied to these pins.

Pin 25 REC DATA — the detector output (after filtering and shaping) is applied to this pin.

Pin 26 $\overline{\text{TX DATA}}$ — applies transmit data to the transmit audio circuits via the data filtering circuits.

Pin 27 LOW SPEED CONTROL — high when transmitting or receiving low speed data; applied to input filter selector and center slicer.

Pin 28 $\overline{\text{CALL}}$ — low to turn on Call light.

Pin 29 EXTERNAL ALARM — low when an external alarm is active.

Pin 30 TICKLE — a positive-going pulse train with a 23.3 millisecond period that is applied to the watchdog timer.

Pin 31 SUBFLEET SWITCH ENABLE — low to enable subfleet switch output to be applied to the microcomputer.

Pin 32 CODE PLUG ENABLE — goes high to enable code plug and to disable the synthesizer strobe signal.

Pins 33-39 CODE PLUG ADDRESSES A0-A6 AND FREQUENCY ASSIGNMENT DATA — applies address to code plug or latch address and data to synthesizer.

Pin 40 CODE PLUG ADDRESS A7 AND SYNTHESIZER STROBE — applies address bit A7 to code plug when code plug is enabled. When code plug is not enabled, pin 40 applies the strobe signal that enables the latches in the PLL integrated circuit.

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SAFE HANDLING OF CMOS INTEGRATED CIRCUIT DEVICES

Many of the integrated circuit devices used in communications equipment are of the CMOS (Complementary Metal Oxide Semiconductor) type. Because of their high open circuit impedance, CMOS ICs are vulnerable to damage from static charges. Care must be taken in handling, shipping, and servicing them and the assemblies in which they are used.

Even though protection devices are provided in CMOS IC inputs, the protection is effective only against overvoltage in the hundreds of volts range such as are encountered in an operating system. In a system, circuit elements distribute static charges and load the CMOS circuits, decreasing the chance of damage. *However, CMOS circuits can be damaged by improper handling of the modules even in a system.*

To avoid damage to circuits, observe the following handling, shipping, and servicing precautions.

1. Prior to and while servicing a circuit module, particularly after moving within the service area, momentarily touch *both* hands to a bare metal earth grounded surface. This will discharge any static charge which may have accumulated on the person doing the servicing.

NOTE

Wearing Conductive Wrist Strap (Motorola No. RSX-4015A) will minimize static buildup during servicing.

WARNING

When wearing Conductive Wrist Strap, be careful near sources of high voltage. The good ground provided by the wrist strap will also increase the danger of lethal shock from accidentially touching high voltage sources.

2. Whenever possible, avoid touching any electrically conductive parts of the circuit module with your hands.

3. Normally, circuit modules can be inserted or removed with power applied to the unit. However, check the INSTALLATION and MAINTENANCE sections of the manual as well as the module schematic diagram to insure there are no objections to this practice.

4. When servicing a circuit module, avoid carpeted areas, dry environments, and certain types of clothing (silk, nylon, etc.) because they contribute to static buildup.

5. All electrically powered test equipment should be grounded. *Apply* the *ground lead* from the test equipment to the circuit module *before* connecting the *test probe*. Similarly, *disconnect* the *test probe prior* to removing the *ground lead*.

6. If a circuit module is removed from the system, it is desirable to lay it on a conductive surface (such as a sheet of aluminum foil) which is connected to ground through 100k of resistance.

WARNING

If the aluminum foil is connected directly to ground, be cautious of possible electrical shock from contacting the foil at the same time as other electrical circuits.

7. When soldering, be sure the soldering iron is grounded.

8. Prior to connecting jumpers, replacing circuit components, or touching CMOS pins (if this becomes necessary in the replacement of an integrated circuit device), be sure to discharge any static buildup as described in procedure 1. Since voltage differences can exist across the human body, it is recommended that only one hand be used if it is necessary to touch pins on the CMOS device and associated board wiring.

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9. When replacing a CMOS integrated circuit device, leave the device in its metal rail container or conductive foam until it is to be inserted into the printed circuit module.

10. All low impedance test equipment (such as pulse generators, etc.) should be connected to CMOS device inputs after power is applied to the CMOS circuitry. Similarly, such low impedance equipment should be disconnected before power is turned off.

11. Replacement modules shipped separately from the factory will be packaged in a conductive material. Any modules being transported from one area to another should be wrapped in a simlar material (aluminum foil may be used). NEVER USE NON-CONDUCTIVE MATERIAL for packaging these modules.

GENERAL MAINTENANCE/ TROUBLESHOOTING

MAINTENANCE PHILOSOPHY

The Trunked FM Radios described in this instruction manual incorporate high component reliability within their design. Servicing when required, can be accomplished to locate the faulty component directly. One area of the radio set, the receiver rf deck, cannot be field serviced. If the rf deck requires servicing, contact your Motorola representative at one of the following locations:

Motorola, Inc.
Product Services
5555 N. Beach
Ft. Worth, Texas 76101
(817) 232-6389

OR

Dallas Service Center
2120 Regency
Irving, Texas 75601
(214) 438-8818

1. TEST EQUIPMENT AND SERVICE AIDS

Table 1 lists the test equipment and service aids recommended for servicing the trunked FM radios described in this instruction manual.

Table 1. Recommended Test Equipment

General Type	Application	Recommended Model	Minimum Specification
AC-DC VOM	DC voltage measurements, general	Motorola T1010A	Measurement range: 0-15 V dc Sensitivity: 20,000 ohms/volt
DC Multimeter	DC voltage readings requiring a high input resistance meter	Motorola R1024A	Measurement range: 0-15 V dc Input resistance: 11 megohms
AC Voltmeter	Audio voltage measurements	Motorola S1053D	Measurement range: 0-1 mV ac Input resistance: 1 megohm
RF Voltmeter	RF voltage measurements	Motorola S1339A	Measurement range: 100 uV-3 V from 1 MHz-900 MHz Inputs: 50 ohm and high impedance
Oscilloscope, Dual-Trace	Waveform observation	Motorola R1029A	Vertical sensitivity: 5 mV-10 V/division Horizontal time base: 0.2 usec.-0.5 sec/division
RF Wattmeter	Transmitter output power measurement	Motorola T1039 with appropriate element and T1013 RF Dummy Load	Measurement range: 0-50 watts
Frequency Meter	Transmitter frequency measurement	Model R1200 Service Monitor with high stability oscillator (X suffix) option. Frequency calibration recommended every 6 months or less.	Measurement range: 806-870 MHz Frequency resolution: 10 Hz
Deviation Meter	Transmitter modulation deviation measurement	Motorola R1200 Service Monitor with RTC4000A Deviation Meter.	Measurement range: 0-10 kHz deviation Frequency range: 806-870 MHz
RF Signal Generator	Receiver alignment and troubleshooting	Motorola R1200 Service Monitor with attenuator	Frequency range: 806-870 MHz Output Level: 0.1 uV-100,000 uV Must be capable of at least ±3 kHz deviation when modulated by 1 kHz tone.
Audio Signal Generator	Audio circuit troubleshooting	Motorola S1067B	Frequency range: 20 Hz-20 kHz Output level: 50 mV-1 V
■Logic Probe	Check Various Digital Devices	Motorola RTL4014A	—

Table 1. Recommended Test Equipment (Cont'd.)

General Type	Application	Recommended Model	Minimum Specification
Radio Test Set	Meter readings at circuit metering points for alignment and troubleshooting	Motorola R1033A Test Set with a RTK4045A Cable. Motorola S1056 Portable Test Set with a RTK4056A Test Set Adapter or a Motorola TEK-5 Meter Panel with a RTK4055A Cable.	
■Tuning Tool Kit	Receiver and transmitter alignment	Motorola HLN4524A	
■DC Power Supply	DC power for shop service	Motorola R1011AA	1-20 V dc 0-40A
■Heated Tweezers	Chip component servicing	Motorola 1-80386A62	
■Temperature Controlled Soldering Iron	General Component Servicing	Motorola 1-80382A44	Temperature Controlled 550°F
■Power Amplifier Service Board	Power Amplifier Servicing	Motorola RTL4112A	
■Magnetic Screwdriver	Radio Servicing	Motorola 1-80382A63	
■TORX Magnetic Bits T15, T20, T25, T30 (For Use With Above)	Radio Servicing	Motorola 66-80385A94	
■TORX T10 Magnetic Bit	Radio Servicing	Motorola 66-80387A74	
■Options Extension Cable	Radio Servicing	Motorola 1-80356A21	

NOTE: All the test equipment listed above, with the exception of those marked with (■), can be replaced with the Motorola R2001B System Analyzer.

2. CHIP COMPONENT REPAIR PROCEDURES

2.1 GENERAL

The trunked radio sets described in this instruction manual employ many chip capacitors, resistors, and diodes as circuit elements. These chip components are located on the solder side of the main, trunked command, and power amplifier circuit boards.

Chip components are positioned in the desired location on the circuit board by a three step, automated process. The first step in the automated process applies two epoxy glue dots to the specified chip component location on the circuit board. The chip component is then applied to the desired location automatically (not by hand). After all chip components are located, and the epoxy glue dots have been allowed to cure, the circuit board is then wave soldered. The epoxy glue is designed to hold the chip components in place during the short wave soldering process.

2.2 CHIP COMPONENT REMOVAL

Chip components are very reliable. Care should be taken while troubleshooting to insure that the part in question is indeed defective before removal is undertaken. If a chip component is deemed defective or visibly damaged, it must be replaced. Several methods can be used to remove the defective part from the circuit board. The exact method used depends upon the skill or experience of the technician, and the available service aids.

2.2.1 Heated Tweezers Method of Removal

A Heated Tweezers System (Motorola Part No. 1-80386A62) allows for easy chip component removal. The tweezers are first heated and then applied to both terminations of the chip component to be removed. After the solder is melted sufficiently, the chip components can be lifted from the circuit board. Refer to Figure 1.

NOTE

If the chip component does not easily lift up after the solder is melted, more heating time is required in order to soften the epoxy glue which originally attached the part to the circuit board before it was soldered.

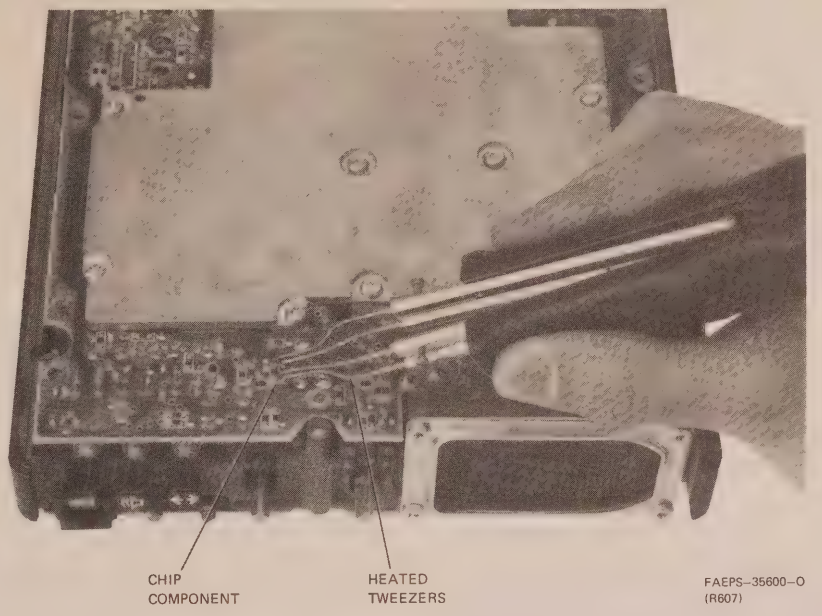

Figure 1. Removal of Chip Component Using a Heated Tweezers

2.2.2 Two Soldering Irons Method of Removal

Two temperature controlled soldering irons (Motorola Part No. 1-80382A44) set at 550°F may be used to remove a defective chip component. This method is similar to the method described in paragraph 2.2.1. Place soldering irons on each termination of the chip component to be removed. After sufficient heating to melt the solder and the epoxy glue (as stated in paragraph 2.2.1) lift the chip part with the two soldering irons from the circuit board. Refer to Figure 2.

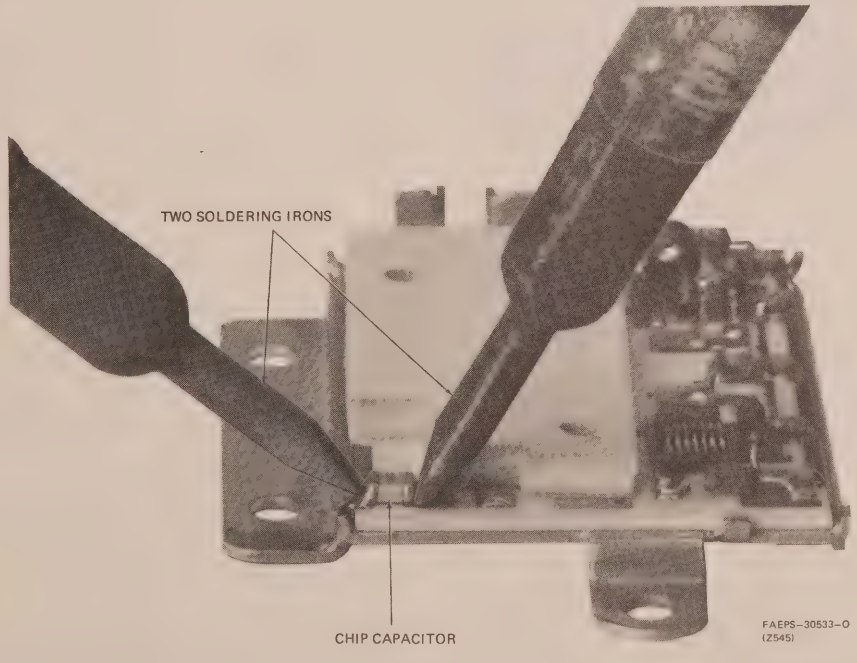

Figure 2. Removal of Chip Component with Two Soldering Irons

2.3 CHIP COMPONENT TESTING

Once a chip resistor is removed from the circuit board it can be tested in the normal manner using any high quality ohmmeter. Chip capacitors should not be reused since internal damage may occur when the part is removed and this damage may not be noticed when the part is tested at room temperature.

2.4 CHIP COMPONENT REPLACEMENT

2.4.1 General

The chip components used in these trunked radio sets are constructed with a tin solder barrier. This barrier greatly reduces the possibility of the chip component to being susceptible to solder "leaching" as shown in Figure 3.

Figure 3. Example of "Leached" Chip Capacitor

As a result, the chip components used in these radio sets are more durable than those previously encountered. Damage is still possible if non-temperature controlled soldering irons are used or if heat is applied to the component for a lengthy period of time. Normal 60-40 tin-lead solder may be used to solder these chip components.

2.4.2 Circuit Board Preparation

Remove any excess solder from the foil location of the chip component by using a solder removal tool or solder braid. Any excess buildup of epoxy glue between these foils must also be removed to insure that the new chip component will solder properly into place. The circuit board is properly prepared when the chip component can be placed on the circuit board and both ends (tabs) of the chip make contact with the mounting foil. The chip should be flush with the circuit board at both ends and the foils should be clean and ready to accept solder.

2.4.3 Installation With Heated Tweezers

Step 1. Insure that the circuit board is prepared properly as discussed in section 2.4.2.

Step 2. Properly position (center) the new chip part on the circuit board foils.

Step 3. Heat the tweezers, and sparingly apply 60-40 tin-lead solder to both ends of the chip part.

Step 4. Insure proper solder wetting at both ends of the chip part and on the circuit board foils before removing the tweezers.

Step 5. Allow the chip part to cool.

Step 6. Visually inspect the chip part to insure that good solder wetting occured and no visible damage to the chip part exists.

2.4.4 Installation With Temperature Controlled Soldering Iron

Step 1. Insure that the circuit board is prepared properly as discussed in section 2.4.2.

Step 2. Properly position (center) the new chip part on the circuit board foils.

Step 3. Heat the soldering iron and apply a small amount of 60-40 tin-lead solder to the tip.

Step 4. Hold the chip part in place with a tweezers or a plastic tuning tool (with metal tip) while soldering one end of the chip part to the circuit board foil.

Step 5. Insure proper solder wetting at the end of the chip part being soldered and on the circuit board foils before removing the soldering iron.

Step 6. Allow the chip part to cool.

Step 7. Solder the remaining end of the chip part in the normal manner.

Step 8. Visually inspect the chip part to insure that good solder wetting occured and no visible damage to the chip part exists.

3. GENERAL SYSTEM TROUBLESHOOTING GUIDE

3.1 A general system troubleshooting guide is provided in Table 2. This table is divided into three sections: symptoms of malfunction, possible source of

trouble, and the procedure to be adopted to clear the fault. The failure symptoms deal with the following conditions:

- No "ON" Indication
- No Receive Audio
- Distorted Receive Audio
- Low Audio Power
- No Regulated 9.6 V or 5.0 V dc
- No RF Power Output
- No Power Control
- Low RF Power Output
- No Transmitter Modulation
- Distorted Transmitter Modulation
- Improper Microphone Sensitivity
- Synthesizer Does Not Lock
- Reference Frequency (6.25 kHz) heard in speaker or on Transmit Audio
- Synthesizer Locks on Wrong Frequency
- Long Synthesizer Lock Time
- Poor Receive Sensitivity
- No Alert Tones
- No High or Low Speed Data Encode

3.2 Depending on the symptom and possible trouble source, refer to the noted troubleshooting charts which are located in this section, and also to the noted schematic diagrams which are located behind the Diagrams and Ancillary Equipment tab in this instruction manual.

Table 2. General System Troubleshooting Guide

Symptom	Possible Source of Trouble	Chart or Diagram To Be Referred To
No "ON" Indication	Power Cable Fuse	Check Fuse
	ON/OFF Switch	Main Board Schematic Diagram
	9.6 V Regulator malfunction	Main Board Schematic Diagram
	Defective Power "ON" LED	Main Board Schematic Diagram
No Receive Audio	Synthesizer Not Locking	Synthesizer Troubleshooting Chart (4)
	Audio Muted	Receive Audio Troubleshooting Chart (2)
	Detector malfunction	Receiver Troubleshooting Chart (6)
	Audio PA malfunction	Receiver Troubleshooting Chart (6)
	Speaker malfunction	Check Speaker and Connections
	JU709 missing	Install JU709 on options connector
Distorted Receive Audio	Audio Limiter malfunction	Main Board Schematic Diagram
	Audio PA malfunction	Receiver troubleshooting chart (6)
	Quad detector malfunction	Receiver troubleshooting chart (6)
	I-F malfunction	Receiver troubleshooting chart (6)
Low Audio Power	Audio PA malfunction	Receiver troubleshooting chart (6)
	Audio Limiter malfunction	Main board schematic diagram
	Quad detector malfunction	Receiver troubleshooting chart (6)
	I-F malfunction	
No Regulated 9.6 V or 5.0 V	Short on printed circuit board	Main board schematic diagram
	Regulator malfunction	Main board schematic diagram
No RF Power Output	PA enable switch	Trunked command board schematic diagram
	Keyed 9.4 switch	
	Synthesizer out-of-lock	Synthesizer troubleshooting chart (4)
	Doubler malfunction	Doubler troubleshooting chart (5)
	Power Control malfunction	Power control troubleshooting chart (8)
	Antenna Switch malfunction	Antenna Switch troubleshooting chart (10)
	PA malfunction	PA troubleshooting chart (9)
	P600 and J600 misaligned	Connector Interconnect location detail
No Power Control	Power Control malfunction	Power control troubleshooting chart (8)
	P600 and J600 misaligned	Connector Interconnect location detail
Low RF Power Output	Power control malfunction	Power control troubleshooting chart (8)
	PA malfunction	PA troubleshooting chart (9)
	Antenna Switch malfunction	Antenna Switch troubleshooting chart (10)
No Transmitter Modulation	Transmit Audio	Transmit Audio Troubleshooting chart (7)
	VCO malfunction	Synthesizer troubleshooting chart (4)
	Mic Mute	Trunked Command board schematic diagram
Distorted Transmitter Modulation	Transmit Audio malfunction	Transmit Audio troubleshooting chart (7)
	VCO malfunction	Trunked command board schematic diagram
Improper Microphone Sensitivity	Transmit Audio malfunction	Transmit Audio troubleshooting chart (7)
	VCO malfunction	Synthesizer troubleshooting chart (4)
	Reference oscillator malfunction	Main board schematic diagram

Table 2. General System Troubleshooting Guide (Cont'd.)

Symptom	Possible Source of Trouble	Chart or Diagram To Be Referred To
Synthesizer Does Not Lock	No 14.4 MHz to J702	Main board schematic diagram
	Ref Osc Malfunction	Main board schematic diagram
	Synthesizer malfunction	Synthesizer troubleshooting chart (4)
	Microcomputer malfunction	Microcomputer schematic diagram
Reference frequency (6.25 kHz) heard in speaker or on transmitted audio	Loop filter malfunction	Synthesizer troubleshooting chart (4)
Synthesizer locks on wrong frequency	Synthesizer malfunction	Synthesizer troubleshooting chart (4)
	Microcomputer malfunction	
	Reference oscillator out-of-adjustment	
Long synthesizer lock time	Synthesizer malfunction	Synthesizer troubleshooting chart (4)
	VCO malfunction	
Poor receive sensitivity	High I-F malfunction	Receiver troubleshooting chart (6). Also refer to main board schematic diagram.
	Low I-F malfunction	
	Quad detector malfunction	
	Preamplifier malfunction	
	First mixer malfunction	
	Second mixer malfunction	
	Antenna Switch malfunction	Antenna switch troubleshooting chart (10)
	Doubler malfunction	Doubler troubleshooting chart (5)
No Alert Tones	Microcomputer malfunction	Microcomputer troubleshooting chart (1)
	Audio PA malfunction	Receiver troubleshooting chart (6)
No High Speed or Low Speed Data Encode	Microcomputer malfunction	Microcomputer troubleshooting chart (1)
	Data filter malfunction	Data filter troubleshooting chart (2)
	Transmit Audio Malfunction	Transmit Audio troubleshooting chart (7)

4. INTEGRATED CIRCUIT VOLTAGE MEASUREMENT TABLES

4.1 The trunked radio sets described in this instruction manual utilize several integrated circuits, including a microcomputer, that perform several complex functions in addition to being highly reliable. The measurement tables indicate expected dc voltages (or functions) at respective pins of the appropriate integrated circuit in a normally functioning radio set while the radio set is in the TEST mode. Note that an incorrect voltage reading could be caused by a defective component as well as the integrated circuit. Refer to the appropriate schematic diagram and troubleshooting chart to assist in locating the defective component.

4.2 The radio set is placed in the TEST mode by momentarily shorting the two pads of TP1600 located on the trunked command circuit board. When TP1600 is shorted, one tone beep is heard in the speaker, and the receiver unsquelches indicating that the radio set is now in the TEST mode. The TEST mode function of the radio set is described in detail in paragraph 5.2.

4.3 The following dc voltage measurement tables are provided as an aid when servicing of the radio set is required.

Table 3. U1601 Microcomputer

Pin No.	Function	Transmit (Mic PTT Low)	Receive (Mic PTT High)
2	$\overline{\text{RESET}}$	4.5 V	4.5 V
3	TRUNK TEST	5.0 V	5.0 V
5	5.9904 MHz Clock	5.9904 MHz	5.9904 MHz
9	ALERT TONES	Toggles for Tone Output	—
11	$\overline{\text{RECEIVE ENABLE}}$	3.5 V	0.5 V
12	MIC MUTE	0.5 V	Float (2.5 V)
14	KEYED 9.4 V CONTROL	3.6 V	0.5 V
15	$\overline{\text{PA ENABLE}}$	0.5 V	Float (2.5 V)
17	PTT	5.0 V	0.5 V
25	REC DATA	Xmit Data	Rec Data
26	$\overline{\text{XMIT DATA}}$	Xmit Data	—
27	LOW/$\overline{\text{HIGH SPEED}}$ CONTROL	3.5 V in CW Mode 3.5 V in Low Speed 0.5 V in High Speed	0.5 V in CW Mode 0.5 V in Low Speed 3.5 V in High Speed
30	TICKLE	(pulsed)*	(pulsed)*

* Refer to waveforms on Trunked Command board schematic diagram.

Table 4. U1000 ÷ 127/128 Prescaler

Pin No.	Voltage
1	Reg. 5.0 V
2	1.7 V
3	1.70 V
4	Ground
5	Ground
6	4.80 V
7	2.90 V
8	3.50 V

Table 5. U1002, Phase-Locked Loop

Pin No.	Voltage
1	*
2	*
3	1.9 V
4	Ground
5	2.0 V
6	Reg. 5.0 V
7	2.1 V
8	2.4 V
9	*
10	*
11	*
12	0.65 V
13	4.9 V
14	4.5 V
15	0.02 V
16	4.7 V
17	4.7 V
18	0.02 V
19	*
20	*

* DC voltage is frequency dependent and may vary between 0.07 V to 4.8 V.

Table 6. U1501, 9.6 V Regulator

Pin No.	Voltage
1	4.0 V
2	5.0 V
3	5.0 V
4	Ground
5	Not Used
6	Not Used
7	Not Used
8	13.8 V

Table 7. U101, Audio Detector

Pin No.	Voltage*
1	2.1 V
2	2.1 V
3	2.1 V
4	Ground
5	Ground
6	5.0 V
7	6.2 V
8	5.5 V
9	5.6 V
10	5.6 V
11	9.3 V
12	3.8 V
13	2.1 V
14	Ground
15	4.8 V
16	Ground

* Voltages indicated are with no RF signal present.

5. RADIO ALIGNMENT AND ADJUSTMENTS

5.1 INTRODUCTION

The trunked FM radios described in this instruction manual are optimally adjusted at the factory and should not require any further adjustments at the time of installation. If, during routine servicing, it is determined that adjustments are necessary, read this entire section carefully prior to making any adjusments.

5.1.1 The following four transmitter adjustments are provided:

- Reference Oscillator Frequency
- Compensation
- Transmitter Modulation Deviation
- Transmitter RF Output Power

The only receiver adjustments allowable are in the receiver I-F sections. These adjustments are:

- Second Injection Level
- First I-F Alignment

The RF deck helical coils (L1-L9) are preset at the factory using special test equipment to allow a wide passband for all frequencies within the 851-870 MHz range. Field adjustment of these helical coils will seriously degrade receiver performance. A single synthesizer adjustment, VCO helical coil, also can be made.

5.1.2 All adjustments except the reference oscillator adjustment, can be performed through holes directly accessible from the solder side of the main circuit board, as shown in Figure 4.

NOTE

Refer to the list of recommended test equipment provided in this section before making any adjustments.

5.2 TRUNKED FM RADIO TEST MODE ROUTINE

5.2.1 General

In normal field operation, the microcomputer in the radio controls rf channel selection, transmitter key-up, and receiver muting functions. However, when the unit is on the bench for a tune-up and is out of its normal operating environment, the microcomputer does not key the PA or unmute the receiver, thus preventing the use of normal tune-up procedures. To solve this problem, a special test routine has been incorporated into the radio.

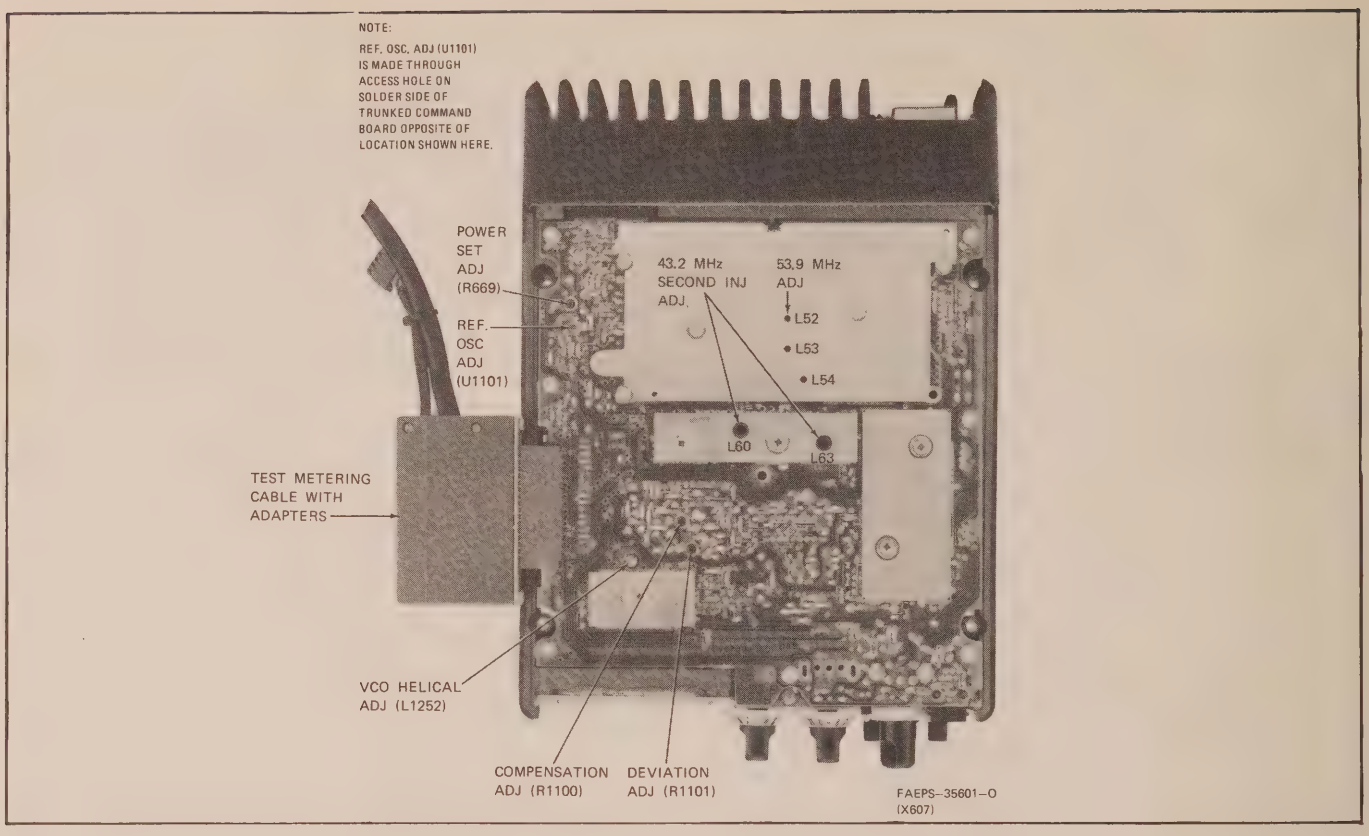

Figure 4. Radio Adjustments Location Detail

5.2.2 Initial Set-Up

The test mode routine can be used in either of the following two ways:

- To service the radio using the four control channel frequencies programmed in the customer code plug (U1602) or,
- To service the radio using the microcomputer internal test code plug frequencies.

To enter the test mode using the customer code plug frequencies, momentarily apply a short across the TEST pads (TP1600) on the solder side of the trunked command board. This test point is also available at the metering card edge connector, P701-15 on the main circuit board. If a code plug is not in the U1602 socket, the radio will not enter the test mode unless the internal code plug of the microcomputer is enabled as described in the following paragraph.

To enter the test mode using the microcomputer internal code plug frequencies, apply a short across the two pads of TP1601 during power-up of the radio. When TP1601 is shorted the Internal Code Plug Select line is grounded. This forces the radio to ignore the customer code plug frequencies and use the following preprogrammed test frequencies:

Internal Code Plug Channel	Receive Frequency	Transmit Frequency
1	851.0125 MHz	806.0125 MHz
2	869.9875 MHz	824.9875 MHz
3	860.5125 MHz	815.5125 MHz

The Internal Code Plug Select line is also available at the metering card edge connector, (P701-6) on the main circuit board.

Operation of the radio in the test mode is described in the following paragraphs and is the same

whether using the customer code plug frequencies or the internal code plug test frequencies.

5.2.3 Channel Selection and Receive Mode

Step 1. Apply power to the radio under test. Momentarily short the test pads together (as described above). A single 450 Hz beep is heard at the speaker to indicate operation on test mode channel 1 (CH 1), after which the receiver unmutes.

Step 2. Step the radio to the next channel by tapping the microphone PTT button (this is achieved by depressing the PTT button and releasing it within 200 milliseconds). Two beeps are heard at the speaker to indicate CH2, after which the receiver unmutes. This procedure can be repeated to step the receiver from CH1 through CH4 with the number of beeps indicating the chosen test channel. (CH1 through CH3 are used for the internal code plug test mode.)

5.2.4 Transmitter Alignment Modes of Operation

Three transmit modes are used for various transmitter checks and adjustments:

- Transmit Mode 1: Silent carrier
- Transmit Mode 2: Subaudible connect tone plus voice (low speed mode)
- Transmit Mode 3: High Speed acknowledge tone (high speed mode)

5.2.4.1 Transmit Mode 1: Silent Carrier

On a given test channel, when the microphone PTT button is depressed once and held, the microcomputer keys the PA without data modulation, and MIC audio is enabled. In this mode, the transmitter frequency, hum and noise, and voice deviation can be checked and adjusted. When the PTT button is released, the PA is dekeyed and the receiver unmutes.

5.2.4.2 Transmit Mode 2: Subaudible Connect Tone Plus Voice (Low Speed Mode)

If the microphone PTT button is depressed and held the second time, the power amplifier is keyed with low speed subaudible tone modulation, and a pulsed 150 Hz tone is heard at the speaker. This 150 Hz tone is the BUSY tone. This procedure is used to adjust the maximum voice plus subaudible tone deviation. Deviation levels are shown below.

- ±3.7 kHz deviation for voice
- ±1 kHz deviation for subaudible connect tone
- ±4.7 kHz deviation total.

When the PTT button is released, the PA is dekeyed and the receiver unmutes.

NOTE

The low speed subaudible tone may be 76.60 Hz, 83.72 Hz, 90.00 Hz, 97.30 Hz, 105.88 Hz, 116.13 Hz, 128.57 Hz, or 138.46 Hz. The specific tone is coded in the code plug, and is a specific tone for a specific system.

5.2.4.3 Transmit Mode 3: High Speed Acknowledge Tone (High Speed Mode)

If the microphone PTT button is depressed and held for the third time, the PA is keyed with 1800 Hz tone modulation. The MIC audio is disabled and a 900 Hz alert tone is heard at the speaker. This tone is known as talk permit. This step is used to check highspeed data deviation. The deviation level should be ±2.75 kHz to 3.25 kHz.

NOTE

Repeated depression and release of the PTT button will cause the radio to recycle through the three modes described above.

5.3 REFERENCE OSCILLATOR FREQUENCY

NOTE

The reference oscillator frequency adjustment should be performed **before** setting or checking the deviation adjustment.

Step 1. Place radio in test mode by momentarily shorting the two indicated test pads on the solder side of the trunked command board. The radio should unmute and a single 450 Hz beep should be heard. The radio is setup on test mode channel 1 (CH1). Refer to the "System Test Parameters" sheet inside packing box. Table 8 illustrates the information provided on the system Test Parameters sheet.

Table 8. Typical System Test Parameters

Test Mode	Rcvr. Freq.	Channel No.	Function
CH1	865937500	597	Control/Voice
CH2	865437500	577	Control/Voice
CH3	864937500	557	Control/Voice
CH4	864437500	537	Control/Voice
	863937500	517	Voice
	863437500	497	Voice
	862937500	477	Voice
	862437500	457	Voice
	861937500	437	Voice
	861437500	417	Voice
	852912500	76	Voice
	852812500	72	Voice
	852712500	68	Voice
	852612500	64	Voice
	852512500	60	Voice
	852412500	56	Voice
	852312500	52	Voice
	851912500	36	Voice
	851812500	32	Voice
	851712500	28	Voice

This sheet is included inside the packing box and shows the technician all frequencies in the system and also indicates which are assigned as control and voice channels.

Step 2. Connect a dummy load and frequency counter to the radio antenna connector.

Step 3. Key the radio without modulation.

Step 4. Using tuning tool Motorola Part No. 66-84974L01, adjust the reference oscillator U1101 warp control (see Figure 4) until the proper indication is obtained on the frequency counter.

5.4 COMPENSATION

NOTE

This procedure sets the ratio of the transmit audio signal between the VCO and the reference oscillator, thus insuring flat modulation response. The compensation adjustment potentiometer R1100 is set at the factory and, normally, does not require readjustment. However, the compensation adjustment procedure should be used whenever any of the following conditions occur in a radio:

(a) if the VCO is repaired,
(b) if the reference oscillator on main circuit board is replaced, and
(c) if the compensation potentiometer is replaced or inadvertently adjusted.

Step 1. Turn the deviation potentiometer (see Figure 4) to its maximum position (counterclockwise as viewed from the solder side of the main board).

Step 2. Connect the center lead of the shielded cable of an ac voltmeter to the steering line test point (TP1000) and connect the shield to the radio ground (A−). Set the voltmeter to the 1 mV range.

Step 3. With the radio in test mode, key transmitter with microphone twice, and maintain the second key. Radio will be in low speed mode and transmitting 15-watt carrier modulated with low speed tone.

Step 4. Adjust the compensation potentiometer until a null indication is obtained on the voltmeter. Recover the access hole with tape to deter accidental adjustment of this control.

5.5 MODULATION DEVIATION

NOTE

Because of the nature of the VCO, its modulation sensitivity tends to vary with the rf carrier frequency. Consequently, while setting deviation, it is important to check deviation especially if wide transmit separations (greater than 5 MHz) are required. This ensures that the radio will not overdeviate.

Step 1. Enter test mode using internal code plug frequencies (see paragraph 5.2.2).

Step 2. Apply a 1 volt rms signal to microphone input and key radio in low speed mode on 815.5125 MHz.

Step 3. Adjust deviation for a total of ±4.7 kHz (1000 Hz tone + low speed tone).

Step 4. Check deviation on all test mode frequenices (806.0125 MHz, 815.5125 MHz and 824.9875 MHz) to insure that radio does not exceed ±5 kHz modulation deviation.

5.6 TRANSMITTER POWER

5.6.1 General 800 MHz Power Measurement Techniques

IMPORTANT

The following information is provided to insure accurate measurment of RF power in the 800 MHz frequency spectrum. The following instructions should be followed **before** performing any transmitter power tests.

The accurate measurement of RF power in the 800 MHz frequency spectrum requires that great care be exercised since these frequencies are at the low end of the microwave spectrum. Test equipment setup and techinques used are more critical for the 800 MHz frequency spectrum than at lower frequencies. Practices that work well for UHF frequencies (and lower) may not provide correct results in the 800 MHz frequency spectrum.

The use of coaxial adapters and cable assembly techniques have a large effect on the accuracy of 800 MHz frequency spectrum power measurements. The use of coaxial adapters should be avoided to the greatest extent possible. Measurements indicate that coaxial adapters, with UHF or BNC connector elements, can have a VSWR exceeding 2:1 in the 800 MHz frequency spectrum. A 2:1 VSWR (due to an adapter), when combined with the antenna or load, can prevent the radio from delivering its rated output power. Figure 5 shows the recommended test set up for measuring power in the 800 MHz frequency spectrum.

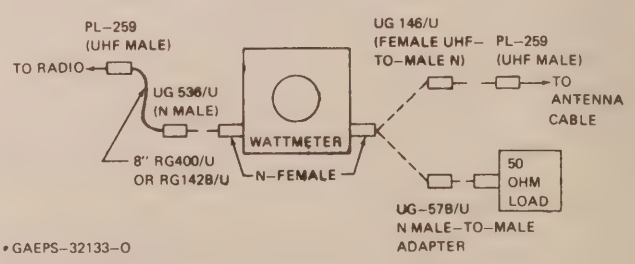

Figure 5. Recommended Test Setup

The wattmeter used for making power measurements should have type N connectors and be rated for use in the 800 MHz frequency spectrum. Motorola Model T1039 (or Bird Model 43) wattmeter is recommended.

To connect the wattmeter to the radio antenna connector, it is necessary to use a type N-to-UHF coaxial adapter cable.

IMPORTANT

This is the only place that a coaxial adapter cable is acceptable.

The connectors used for the coaxial adapter cable should incorporate a Teflon or "plastic" insulating dielectric (such as Motorola Part number: 58-82272C01). Older connectors, constructed with bakelite (a hard, brown colored material) as the insulating dielectric, or low cost adapters intended for citizens band service, should **NOT** be used.

The coaxial cable, used to adapt the UHF antenna connector on the radio to the type N connector on the wattmeter, should be of a high quality type, preferably with Teflon as the dielectric material. Cable types such as RG400/U (Motorola part number: 30-84173E01) or RG142B/U (Motorola part number: 30-83278B01) are recommended. Great care should be exercised in the assembly of the coaxial adapter cable in order to minimize impedance discontinuities at the connectors.

Since accurate power measurements in the 800 MHz frequency spectrum are more difficult than at lower frequencies, care taken with the measuring system and its use is well worth the extra time and effort.

NOTE

The previously described techniques are recommended for other types of Motorola two-way FM radios that operate in the 800 MHz freqeuency spectrum.

5.6.2 Power Set Procedure, 15 W Power Output

Step 1. Terminate the radio with a wattmeter and a 50-ohm load.

Step 2. Adjust the dc power supply voltage to 13.8 V.

NOTE

Since the transmitter employs a broadband power amplifier, any channel may be selected for the power adjustment procedure.

Step 3. Enter test mode using internal code plug frequencies (see section 5.2.2.)

Step 4. Key the transmitter on 815.5125 MHz and adjust the POWER SET potentiometer (see Figure 4) for an output power indication of 16.5 W. A clockwise adjustment of this potentiometer (as viewed from the bottom of the radio) increases the output power, whereas a counterclockwise adjustment decreases the output power.

5.7 RECEIVER ADJUSTMENT

5.7.1 General

Readjustment of the entire receiver is usually not necessary since the receiver is preadjusted at the factory (with special test equipment) to allow a wide passband for all frequencies within the 851-870 MHz range. Only certain field receiver adjustments gnerally are necessary. These adjustments are explained in the following paragraph. The RF deck (receiver front end) is **NOT field adjustable**. See page 1 of this section for information on where to return RF deck for service if failure should occur.

CAUTION

Do *not* attempt to adjust helical coils L1 through L9. These coils are preset at the factory with special test equipment. Any attempt to readjust L1 through L9 will seriously degrade the receiver performance.

5.7.2 Test Equipment Setup

Step 1. If using Motorola S1056 portable test set and cable or equipment, set controls as follows unless otherwise specified: Oscillator switch off; function switch, receiver.

Step 2. If using Motorola TEK-5 meter panel with TEK-40 *Micor* adapter or equipment, set TEK-40 selector switch to position "C".

Step 3. Use tuning tool (Motorola Part Number 66-82977K01) for all adjustments.

5.7.3 Receiver Adjustments

(Refer to Figure 4)

Step 1. 43.2 MHz second injection alignment — tune L60 and L63 for peak reading on meter 6.

Step 2. 53.9 MHz I-F alignment — connect RF signal generator to antenna input and adjust level to 20-30 dBQ. Adjust L52, L53, and L54 for peak reading on Meter 1.

5.8 SYNTHESIZER VCO HELICAL COIL ADJUSTMENT PROCEDURE

The following procedure should be used, if any component in the VCO oscillator circuit is replaced.

Step 1. Terminate the radio with a 50-ohm load, connected to the antenna connector J610.

Step 2. Put the radio into the test mode using the internal code plug frequencies (see section 5.2.2).

Step 3. Connect a digital dc voltmeter to the VCO steering line test point (TP1000).

Step 4. With the radio set to receive on CH1 (851.0125 MHz), adjust the VCO helical coil (L1252) such that the TP1000 reading is greater than or equal to 1.6 Vdc.

NOTE

Two possible tuning cores can be used for L1252. A longer core Motorola Part No. 3-80059D01) may be needed if this procedure results in core position that is below the jam nut on L1252. A shorter core (Motorola Part No. 3-80079D01) may be needed if this procedure results in a core position that interferes with the radio housing covers.

Step 5. Key the radio on CH2 (824.9875 MHz) and, if necessary, readjust L1252 until TP1000 measures less than or equal to 7.5 Vdc.

Step 6. Repeat Steps 4 and 5 until both conditions are met. If both conditions are not met, further repair may be needed. Go to the synthesizer Open Loop Test Procedure in section 9.

6. IPA AND POWER AMPLIFIER MODULE TEST PROCEDURES

6.1 GENERAL

The following procedures can be followed if low gain components are suspect. The entire power amplifier troubleshooting chart should already have been followed before reaching this point.

It will be necessary to make a test cable for these test procedures. The test cable is made in the following manner:

Step 1. Assemble a type "N" male connector to one end of a 6-inch length of RG142B/U or RG400/U coax cable.

Step 2. Cut and strip the other end of the cable so that 3mm of center conductor, 3mm of dielectric, and 6mm of ground braid is exposed.

(3mm = .12", 6mm = .24")

6.2 IPA TEST PROCEDURE

(Refer to Figure 6)

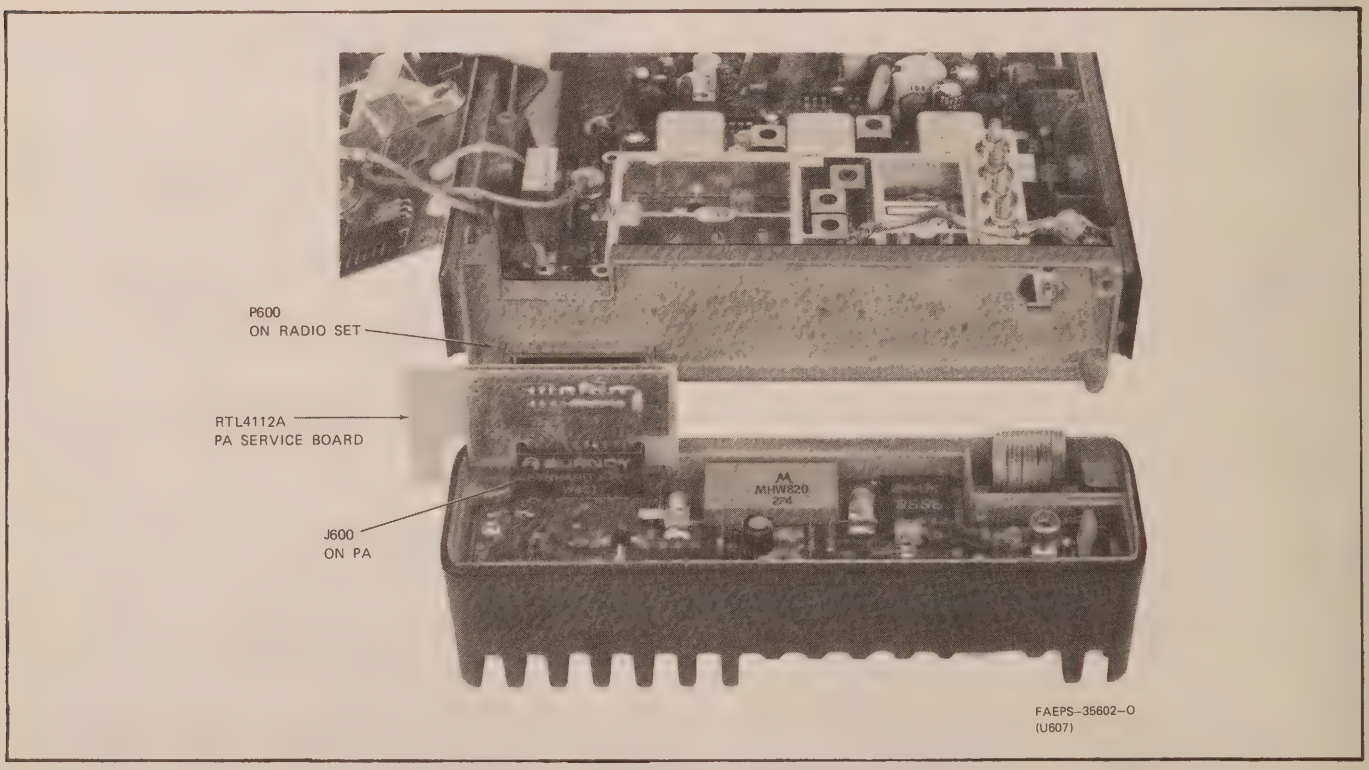

Figure 6. Power Amplifier Service Board Connected Between PA and Radio Set

NOTE

The power amplifier troubleshooting chart should already have been followed up to the RF millivolter measurement test before following this procedure.

Step 1. Remove A + (13.8 V) from the radio.

Step 2. Unsolder and lift lead 1 of U600 from circuit board (refer to PA Module Removal Procedure paragraph 7 in this section).

Step 3. Solder one side of a 39 pF (Motorola Part No. 21-11033B27) high "Q" chip capacitor to the circuit board where pin 1 of U600 was connected.

Step 4. Solder center conductor of test coax cable to other side of capacitor.

Step 5. Solder ground braid of test cable to PA module grounding strap.

Step 6. Connect the other end of test cable to thruline wattmeter terminated in 50 ohm load. Wattmeter should have 2.5 W element rated for 800 MHz.

Step 7. Apply A + (13.8 V) to radio and key the radio.

Step 8. Measure output power. It should be greater than 0.20 watts.

Step 9. If power is less than 0.20 watts, check IPA components and replace as required. Replace Q250 *only* if all other components check ok.

Step 10. Remove capacitor and coax cable from circuit board and reconnect lead 1 of U600.

6.3 PA MODULE TEST PROCEDURE

NOTE

The power amplifier troubleshooting chart should already have been followed to the point where total radio current drain is measured before following this procedure.

Step 1. Remove A + (13.8 V) from the radio.

Step 2. Unsolder and lift lead 5 of U600.

Step 3. Solder the center conductor of test coax cable to PA module grounding strap.

Step 4. Connect the test cable to the wattmeter per IPA procedure, using a 25 watt wattmeter element rated at 800 MHz.

Step 5. Apply A + (13.8 V) to radio and key radio.

Step 6. Measure output power. It should be greater than 18 watts.

Step 7. If power is less than 18 watts, and IPA drive is verified, then replace U600.

Step 8. Remove the test cable and resolder lead 5 of U600.

7. POWER AMPLIFIER MODULE AND POWER AMPLIFIER BOARD REMOVAL PROCEDURE

7.1 GENERAL

Step 1. Loosen two hex screws on the rear of the PA heat sink and carefully remove PA assembly from the radio chassis.

Step 2. Remove PA shield.

7.2 POWER AMPLIFIER MODULE REMOVAL

CAUTION

The PA module leads are very fragile. Care should be exercised in not bending or pulling excessively on the leads. If a lead breaks, the PA module must be replaced.

Step 1. Using a 550°F soldering iron with a small tip, carefully unsolder each lead and remove excess solder. At this point, some solder may still be holding one or more leads of the module to the circuit board.

Step 2. Using a dental pick (or similar tool), carefully lift the lead (or leads) from the circuit board while applying just enough heat from the soldering iron to melt solder.

Step 3. Clear away any excess solder and go on to next lead (or leads) until all leads are free of the circuit board.

Step 4. Remove two screws from PA module (U600).

Step 5. Unsolder ground strap nearest the antenna connector. Do *not* unsolder the ground strap with the thermistor.

Step 6. Slide PA module out from under the remaining ground strap being careful to keep the PA module leads above the circuit board.

Step 7. Carefully lift PA module from heat sink.

7.3 POWER AMPLIFIER BOARD REMOVAL

Step 1. Remove two screws from power connector J650.

Step 2. Connect radio set power cable to power connector J650 with power supply turned off.

Step 3. Carefully unsolder the power connector pins from the board. Remove excess solder until the holes are clear.

Step 4. Using the power cable connector as an aid, gently pull until power connector J650 comes out of the board.

Step 5. Remove the three screws from the PA circuit board.

Step 6. Unsolder the antenna connector, J610 (by L702) carefully, and gently lift PA board from the heat sink.

Step 7. Heat the area of the circuit board where the center conductor of the antenna connector, J610 (by L702), contacts the board. When the solder flows, gently lift the PA board from the heat sink.

Step 8. Remove any excess solder that may exist on antenna connector, power plug pins, and circuit board holes associated with PA board removal.

8. POWER AMPLIFIER BOARD AND POWER AMPLIFIER MODULE INSTALLATION

NOTE

If PA board has not been removed go directly to section 8.2.

8.1 POWER AMPLIFIER BOARD INSTALLATION

Step 1. Reinstall power connector J650 into heat sink with two screws previously removed.

Step 2. Reinstall antenna connector J610.

Step 3. Reinstall PA board with three screws previously removed.

Step 4. Solder connections at J650 and J610 with sufficient new solder.

8.2 POWER AMPLIFIER MODULE INSTALLATION

Step 1. Apply a *thin* coating of silicon grease such as Motorola Part No. 11-83166A01, to the shelf in the heat sink. Do the same to the flange of the PA module.

NOTE

Excessive use of silicon grease can degrade the thermal efficiency of the heat sink.

Step 2. Carefully install PA module by sliding it under the remaining thermistor ground strap. Be careful to keep the PA module leads above the circuit board.

Step 3. Reconnect ground strap that was previously removed.

Step 4. Align PA module leads with circuit board pads as closely as possible. Use care when aligning leads to pads on circuit board.

Step 5. Install and tighten PA module mounting screws. When tightening screws, alternate between the screws to achieve proper seating of the PA module in the heat sink.

Step 6. Solder PA module leads to circuit board.

NOTE

Make certain that thermistor R600 makes contact with PA module ground strap and that no thermistor short exists.

Step 7. Replace PA shield.

9. SYNTHESIZER OPEN LOOP TEST PROCEDURE

9.1 GENERAL

In the frequency synthesizer troubleshooting chart, mention is made of an open loop test. This procedure is described in the following paragraphs and is not accompanied by a flow chart.

9.2 OPEN LOOP TEST

9.2.1 Introduction

The synthesizer troubleshooting chart refers to the open loop test. Use of the following test equipment is required for this test: variable dc power supply, frequency counter, dual-trace oscilloscope, dc voltmeter and rf voltmeter. Refer to the list of recommended test equipment provided in this section of this manual, and also to the synthesizer schematic diagram and trunked command board circuit detail.

The open loop test consists of three procedures:

- VCO frequency test
- Loop and reference waveforms test
- VCO steering line leakage test

9.2.2 VCO Frequency Test

Step 1. Position the trunked command board so the component side is up, and remove the cover from the board. Unsolder the end of L1250 closest to L1251 from the PC board.

Step 2. Connect one end of a 1k resistor to the positive terminal of a 0-10 V dc adjustable power supply, and connect the other end of the resistor to the free end of

L1250. Connect the negative terminal of the power supply to chassis A−. This power supply will serve as a steering line in this test.

Step 3. Connect a frequency counter to the synthesizer output cable P703.

Step 4. While monitoring the VCO output frequency, slowly change the steering line voltage from 1.6 V to 7.5 V. Verify that the desired synthesizer output frequency appears at some voltage in this range. The frequency should range from 398.0 to 412.6 MHz across the voltage range mentioned above. If it does not, the problem area is the steering line circuit L1250, CR1250, CR1251 and C1254. Refer to Table 9 for problems and possible causes.

Table 9. VCO Frequency Problems and Possible Causes

Problem	Possible Causes
1. Frequency does not change when voltage is varied from 1.6 V to 7.5 V:	
a. Frequency is approximately 390 MHz.	L1250 open or CR1251 shorted.
b. Frequency is approximately 445 MHz.	C1254 open
c. Frequency is approximately 320 MHz.	CR1250 open
d. No power output	CR1250 shorted.
2. Frequency varies but only 2 MHz and low power output.	CR1251 open

Step 5. After repair, reconnect L1250 to the circuit board and refer to the Synthesizer Troubleshooting chart and continue on.

9.2.3 Loop and Reference Waveforms Test

(Refer to Synthesizer Schematic Diagram)

Step 1. Connect one channel of a dual-trace oscilloscope to U1002-18 (TP1002) and the other oscilloscope channel to U1002-15 (TP1003). Adjust oscilloscope so it triggers on the reference waveform at TP1002. The oscilloscope trace should be in the chopped mode. Set the horizontal time to 20 microseconds per division.

Step 2. Observe the waveform at TP1003 and verify that it is moving smoothly across the screen without any jitter when the steering line is varied from 1.6 V to 7.5 V. The second pulse at approximately 160 microseconds is the pulse that will move.

Step 3. Observe the waveform at TP1002 and verify that its time period is also 160 microseconds without any jitter, and does not move at any steering line voltage from 1.6 V to 7.5 V.

Step 4. If the conditions specified in Steps 2 and 3 are not met, then the following must be checked: Feedback Amplifier Q1253, and the synthesizer programming.

Step 5. The output of U1000 can be checked by capacitively coupling a 50 MHz frequency counter to pin 7 and verifying that the output is approximately 1/127 of the input frequency (which is the VCO output frequency). A frequency counter will not provide an exact indication of 1/127 of the input frequency, since the prescaler is dividing by 128 part of the time. The difference should not exceed 50 ppm.

Refer to the synthesizer troubleshooting chart for repair or replacement information for the affected component.

9.2.4 VCO Steering Line Leakage

The VCO steering line leakage can be checked by removing the same end of L1250 as in paragraph 9.2.2 Step 1 and connecting a 1 megohm resistor to L1250. The free end of the resistor should be connected to an adjustable power supply set to 9.5 V. A high-impedance voltmeter (impedance greater than 10 megohms) should abe used to verify that the voltage drop across the resistor is less than 10 mV. Be sure to use a shielded cable with the voltmeter when making these measurements. A higher voltage drop (greater than 10 mV) is an indication of defective VCO steering line varactors CR1250 and CR1251.

RADIO SYSTEM TROUBLESHOOTING CHARTS

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ROUGH TRUNKED COMMAND
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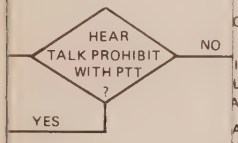

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L CHANNEL FREQUENCY PRO–
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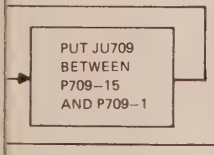
AWLESSLY BUT STILL NOT WORK
EN DENIED ACCESS BY SYSTEM

ICROCOMPUTER,AND SYNTHESIZER

RT FOR MICROCOMPUTER SYSTEM

RT FOR RECEIVE AUDIO SECTION



RT FOR DATA FILTER – CENTER
OARD.
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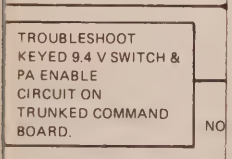

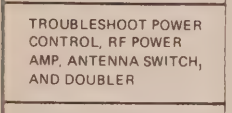

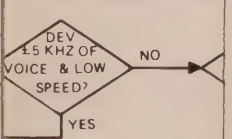

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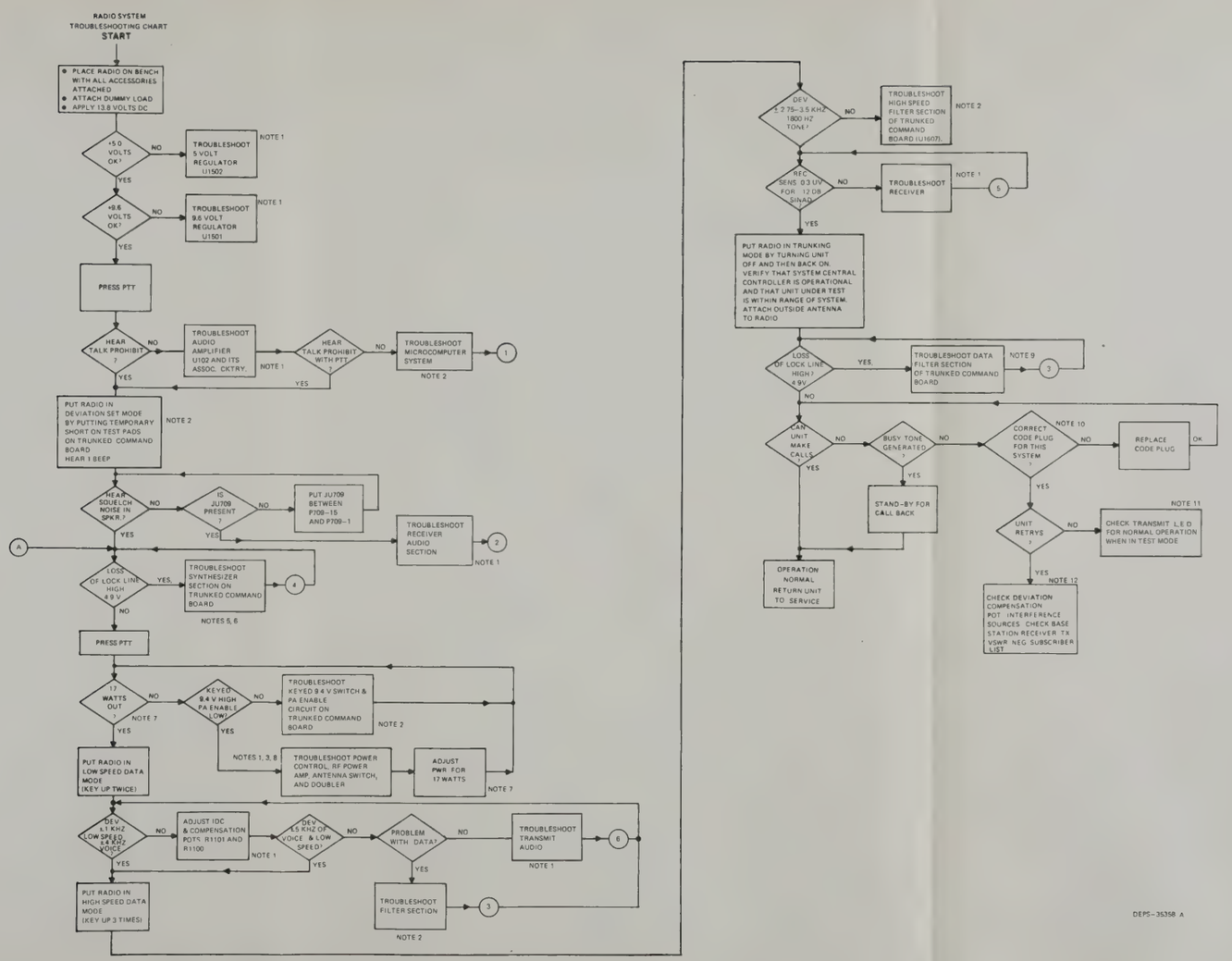
RADIO SYSTEM TROUBLESHOOTING CHARTS

RADIO SYSTEM



NOTES

1. REFER TO MAIN BOARD SCHEMATIC DIAGRAM
2. REFER TO TRUNKED COMMAND BOARD SCHEMATIC DIAGRAM
3. REFER TO PA BOARD SCHEMATIC DIAGRAM
4. IF NO NOISE IS HEARD, VERIFY THAT RECEIVER SECTION IS GENERATING NORMAL SQUELCH NOISE. REFER TO RECEIVER PORTION OF MAIN BOARD SCHEMATIC DIAGRAM
5. MICROCOMPUTER MAY NOT BE PROGRAMMING THE SYNTHESIZER PROPERLY REFER TO SYNTHESIZER SECTION TROUBLESHOOTING CHART ALSO REFER TO TRUNKED COMMAND BOARD SCHEMATIC DIAGRAM
6. SYNTHESIZER MAY NOT BE ACCEPTING PROGRAMMING INFORMATION FROM MICROCOMPUTER. REFER TO FREQUENCY SYNTHESIZER SCHEMATIC DIAGRAM
7. POWER OUT FROM PA SHOULD BE MEASURED AT ANTENNA CONNECTOR
8. IF KEYED 9.4 VOLTS IS PRESENT AND PA ENABLE LINE IS LOW, RADIO SHOULD GENERATE RATED POWER OUTPUT. POWER CONTROL AND DOUBLER CIRCUITS ARE ON CIRCUIT BOARD. REFER TO APPROPRIATE TROUBLESHOOTING CHARTS AND RETURN HERE
9. IF LOSS-OF-LOCK LED IS FLASHING, RADIO IS SCANNING FOR CONTROL CHANNEL. VERIFY THAT CONTROL CHANNEL DATA IS GETTING TO MICROCOMPUTER BY TRACING SIGNAL THROUGH TRUNKED COMMAND BOARD FILTER SECTION AND CENTER SLICER SECTION. DATA SHOULD BE PRESENT ON PIN 25 OF MICROCOMPUTER WHEN RADIO SCANS CONTROL CHANNEL. REFER TO TRUNKED COMMAND BOARD SYNTHESIZER SECTION AND CENTER SLICER SECTION TROUBLESHOOTING CHARTS
10. MOBILE COULD BE LICENSED ON ANOTHER SYSTEM WITH SAME FREQUENCIES AS LOCAL SYSTEM, BUT SYSTEM ID DOES NOT MATCH AND RADIO CAN NOT MAKE CALLS
11. IF RED TX LED IN MOBILE CONTROL HEAD IS BURNED OUT OR REMOVED RADIO WILL REVERT TO HIGHEST CONTROL CHANNEL FREQUENCY PROGRAMMED IN CODE PLUG. THIS IS A FAILSAFE FEATURE
12. IT IS POSSIBLE FOR RADIO TO OPERATE FLAWLESSLY BUT STILL NOT WORK IN THE SYSTEM IF THE SUBSCRIBER HAS BEEN DENIED ACCESS BY SYSTEM OWNER

LEGEND

- (A) REFERS TO INPUT FROM RECEIVE AUDIO, MICROCOMPUTER, AND SYNTHESIZER TROUBLESHOOTING CHARTS
- (1) REFERS TO TROUBLESHOOTING FLOW CHART FOR MICROCOMPUTER SYSTEM ON TRUNKED COMMAND BOARD
- (2) REFERS TO TROUBLESHOOTING FLOW CHART FOR RECEIVE AUDIO SECTION ON MAIN CIRCUIT BOARD
- (3) REFERS TO TROUBLESHOOTING FLOW CHART FOR DATA FILTER – CENTER SLICER SECTION ON TRUNKED COMMAND BOARD
- (4) REFERS TO TROUBLESHOOTING FLOW CHART FOR SYNTHESIZER SECTION ON TRUNKED COMMAND BOARD.
- (5) REFERS TO RECEIVER TROUBLESHOOTING CHART.
- (6) REFERS TO TRANSMIT AUDIO TROUBLESHOOTING CHART

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(Sheet 1 of 11)
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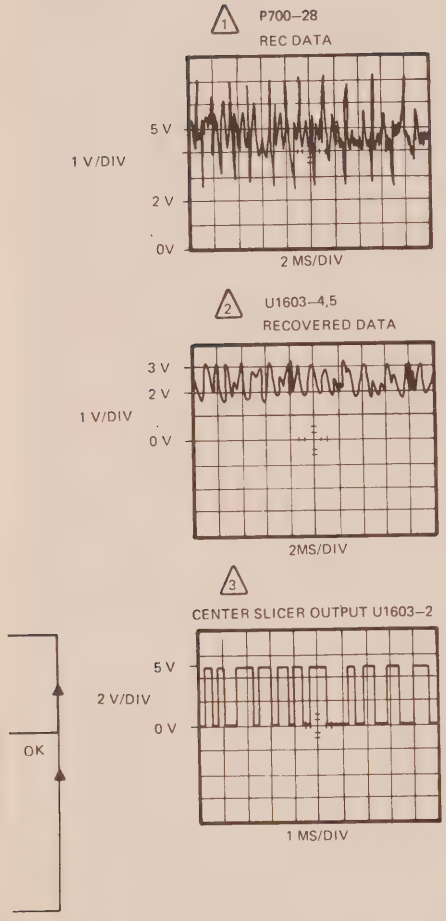


NOTES:

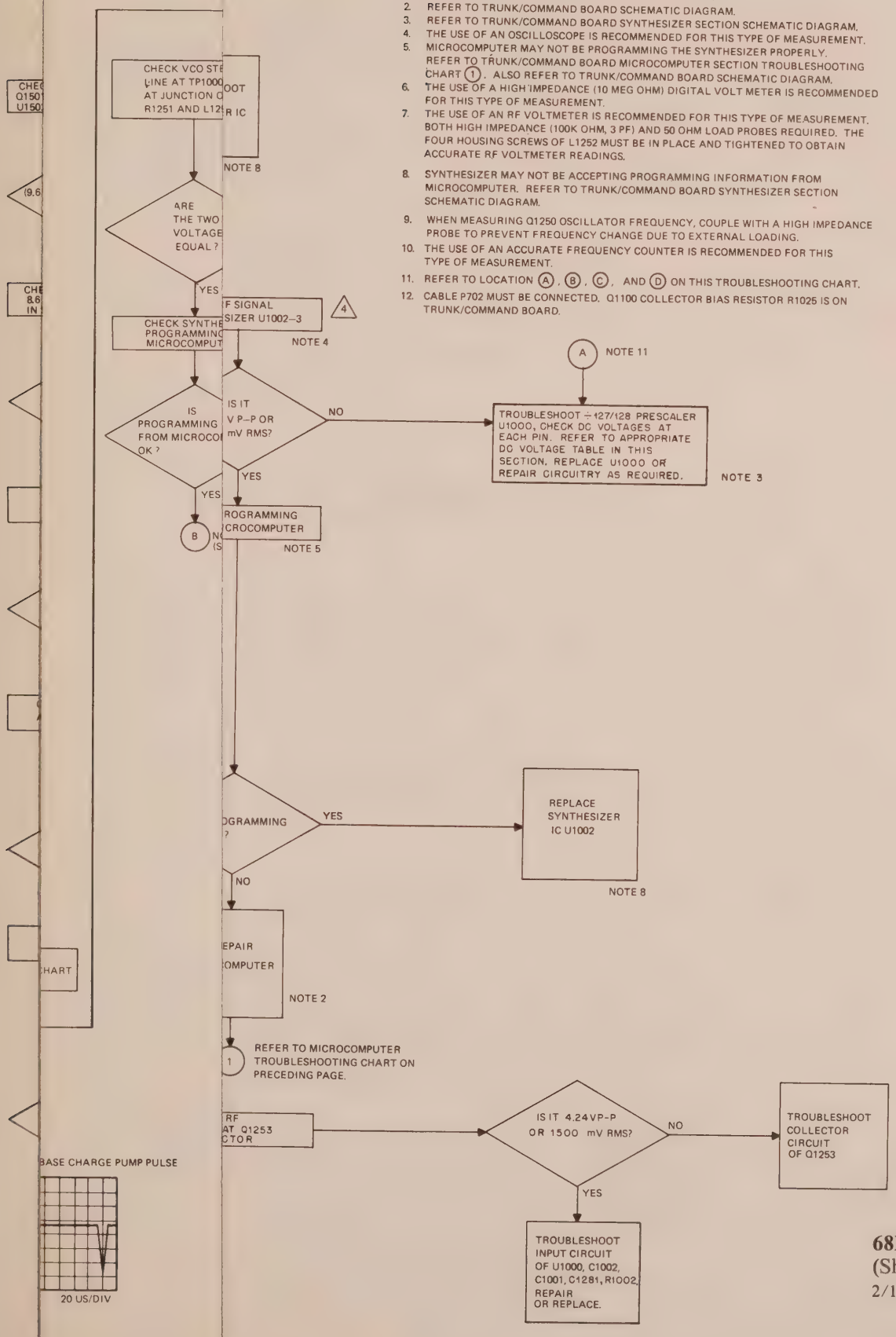
1. REFER TO RECEIVER AUDIO TROUBLESHOOTING CHART ②.
2. REFER TO TRUNKED COMMAND BOARD SCHEMATIC D!AGRAM.

RADIO SYSTEM TROUBLESHOOTING CHARTS

SYNTHESIZER

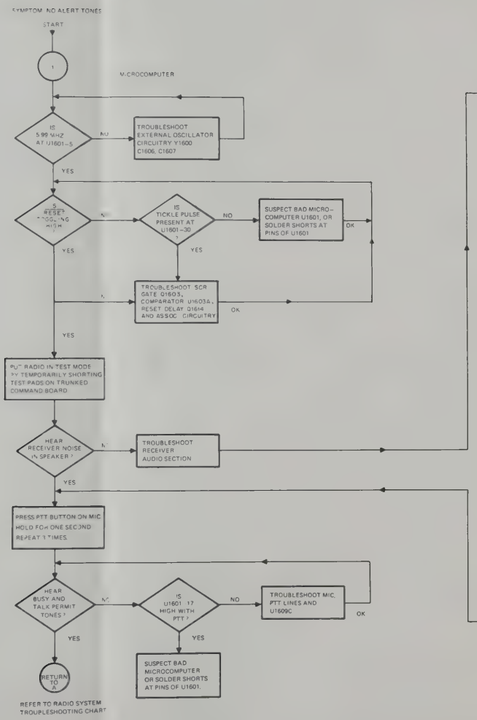
NOTES:

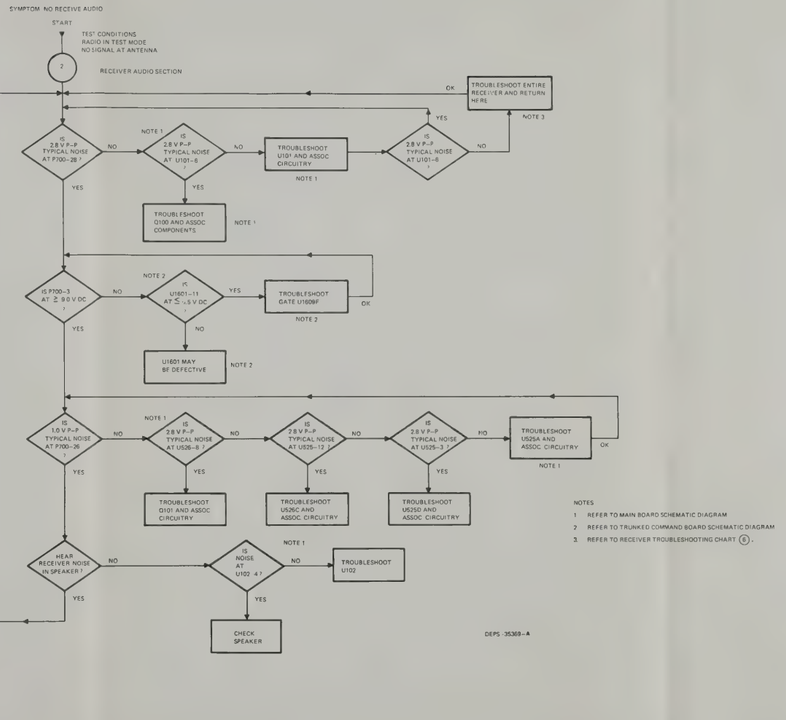
1. REFER TO MAIN CIRCUIT BOARD SCHEMATIC DIAGRAM.
2. REFER TO TRUNK/COMMAND BOARD SCHEMATIC DIAGRAM.
3. REFER TO TRUNK/COMMAND BOARD SYNTHESIZER SECTION SCHEMATIC DIAGRAM.
4. THE USE OF AN OSCILLOSCOPE IS RECOMMENDED FOR THIS TYPE OF MEASUREMENT.
5. MICROCOMPUTER MAY NOT BE PROGRAMMING THE SYNTHESIZER PROPERLY. REFER TO TRUNK/COMMAND BOARD MICROCOMPUTER SECTION TROUBLESHOOTING CHART (1). ALSO REFER TO TRUNK/COMMAND BOARD SCHEMATIC DIAGRAM.
6. THE USE OF A HIGH IMPEDANCE (10 MEG OHM) DIGITAL VOLT METER IS RECOMMENDED FOR THIS TYPE OF MEASUREMENT.
7. THE USE OF AN RF VOLTMETER IS RECOMMENDED FOR THIS TYPE OF MEASUREMENT. BOTH HIGH IMPEDANCE (100K OHM, 3 PF) AND 50 OHM LOAD PROBES REQUIRED. THE FOUR HOUSING SCREWS OF L1252 MUST BE IN PLACE AND TIGHTENED TO OBTAIN ACCURATE RF VOLTMETER READINGS.
8. SYNTHESIZER MAY NOT BE ACCEPTING PROGRAMMING INFORMATION FROM MICROCOMPUTER. REFER TO TRUNK/COMMAND BOARD SYNTHESIZER SECTION SCHEMATIC DIAGRAM.
9. WHEN MEASURING Q1250 OSCILLATOR FREQUENCY, COUPLE WITH A HIGH IMPEDANCE PROBE TO PREVENT FREQUENCY CHANGE DUE TO EXTERNAL LOADING.
10. THE USE OF AN ACCURATE FREQUENCY COUNTER IS RECOMMENDED FOR THIS TYPE OF MEASUREMENT.
11. REFER TO LOCATION (A), (B), (C), AND (D) ON THIS TROUBLESHOOTING CHART.
12. CABLE P702 MUST BE CONNECTED. Q1100 COLLECTOR BIAS RESISTOR R1025 IS ON TRUNK/COMMAND BOARD.



RADIO SYSTEM TROUBLESHOOTING CHARTS

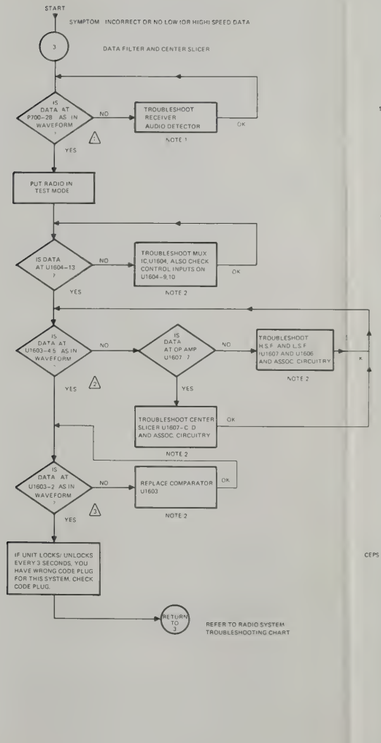
MICROCOMPUTER
RECEIVER AUDIO SECTION
DATA FILTER & CENTER SLICER

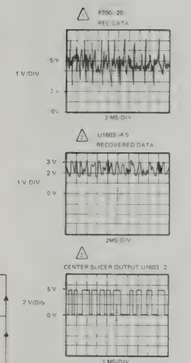




NOTES
1. REFER TO MAIN BOARD SCHEMATIC DIAGRAM
2. REFER TO TRUNKED COMMAND BOARD SCHEMATIC DIAGRAM
3. REFER TO RECEIVER TROUBLESHOOTING CHART (6).

DEPS-35369-A



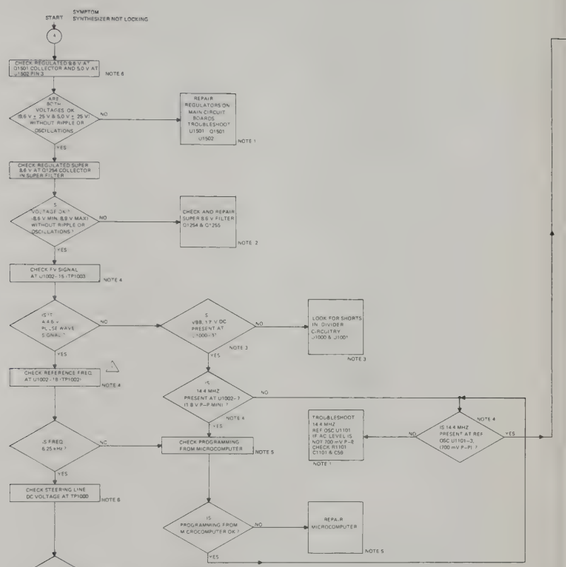


NOTES
1. REFER TO RECEIVER AUDIO TROUBLESHOOTING CHART (2)
2. REFER TO TRUNKED COMMAND BOARD SCHEMATIC DIAGRAM

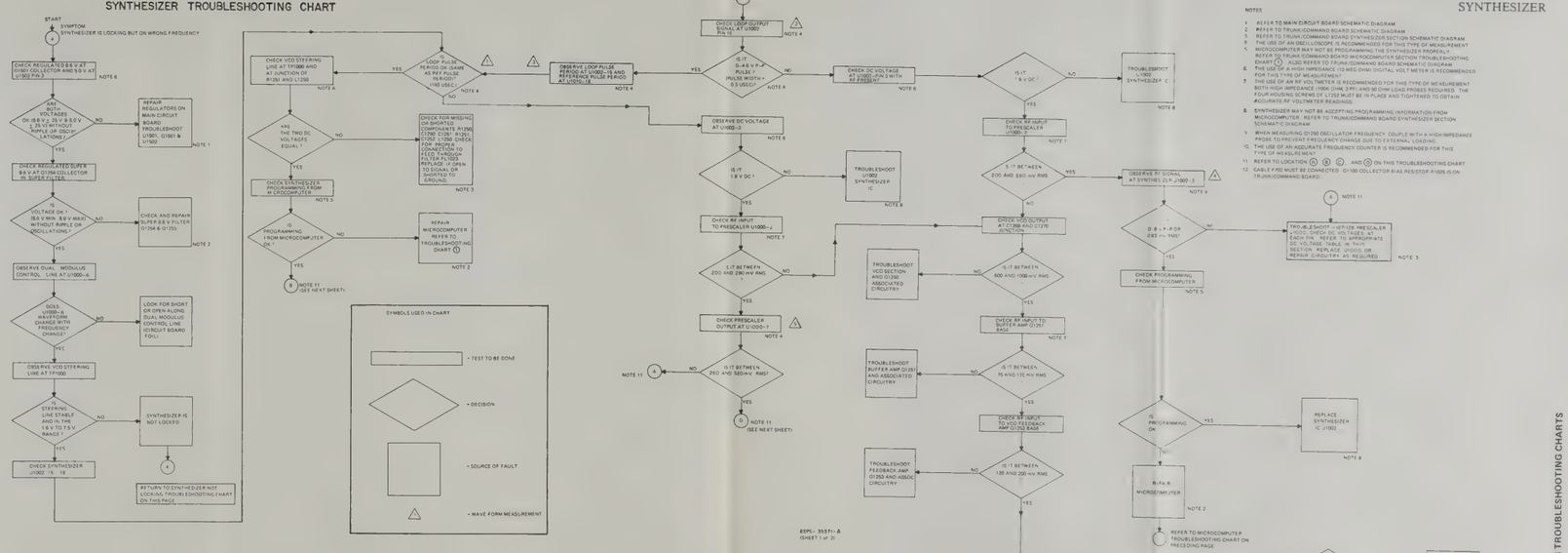
CEPS-35370-A

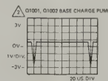
RADIO SYSTEM TROUBLESHOOTING CHARTS

SYNTHESIZER



SYNTHESIZER TROUBLESHOOTING CHART





EEPS- 3537- A
SHEET 1 of 2

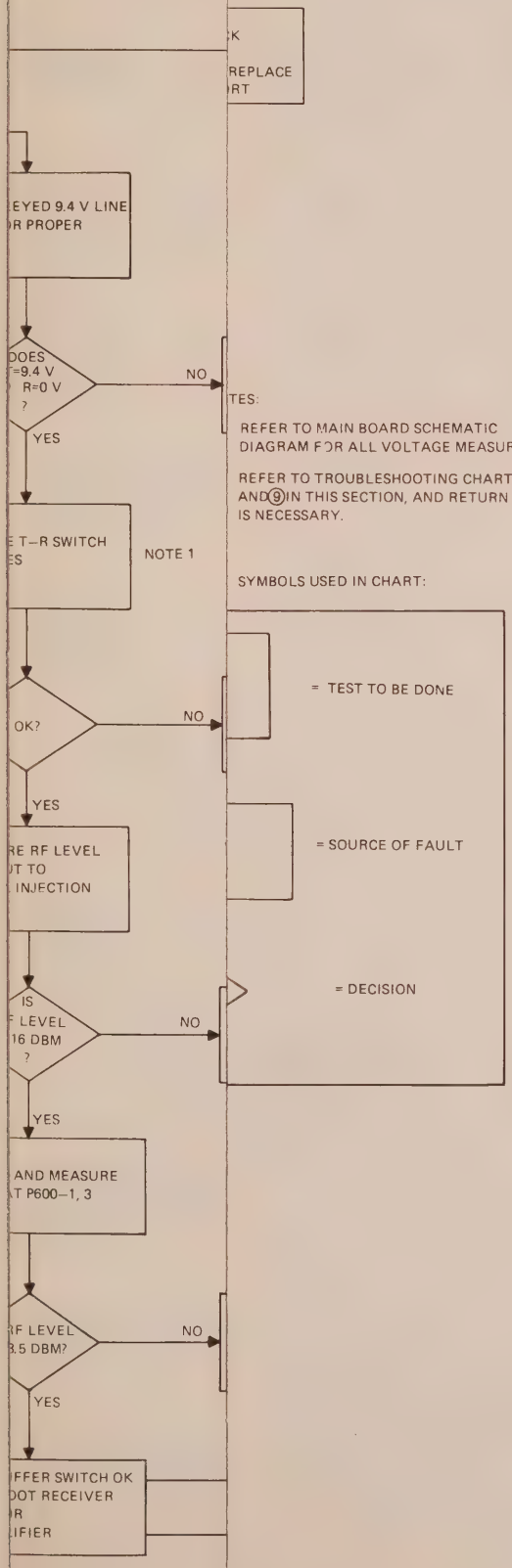
NOTES

1. REFER TO MAIN CIRCUIT BOARD SCHEMATIC DIAGRAM
2. REFER TO TRUNK/COMMAND BOARD SCHEMATIC DIAGRAM
3. REFER TO TRUNK/COMMAND BOARD SYNTHESIZER SECTION SCHEMATIC DIAGRAM
4. THE USE OF AN OSCILLOSCOPE IS RECOMMENDED FOR THIS TYPE OF MEASUREMENT
5. MICROCOMPUTER MUST BE PROGRAMMED THE SYNTHESIZER PROPERLY. REFER TO TRUNK/COMMAND BOARD MICROCOMPUTER SECTION TROUBLESHOOTING CHART (C). ALSO REFER TO TRUNK/COMMAND BOARD SCHEMATIC DIAGRAM
6. THE USE OF A HIGH IMPEDANCE (10 MEG OHM) DIGITAL VOLT METER IS RECOMMENDED FOR THIS TYPE OF MEASUREMENT
7. THE USE OF AN RF VOLTMETER IS RECOMMENDED FOR THIS TYPE OF MEASUREMENT BOTH HIGH IMPEDANCE (100K OHM, 3 PF) AND 50 OHM LOAD PROBES REQUIRED. THE FOUR HOUSING SCREWS OF L1253 MUST BE IN PLACE AND TIGHTENED TO OBTAIN ACCURATE RF VOLTMETER READINGS.
8. SYNTHESIZER MAY NOT BE ACCEPTING PROGRAMMING INFORMATION FROM MICROCOMPUTER. REFER TO TRUNK/COMMAND BOARD SYNTHESIZER SECTION SCHEMATIC DIAGRAM
9. WHEN MEASURING Q1250 OSCILLATOR FREQUENCY, COUPLE WITH A HIGH IMPEDANCE PROBE TO PREVENT FREQUENCY CHANGE DUE TO EXTERNAL LOADING
10. THE USE OF AN ACCURATE FREQUENCY COUNTER IS RECOMMENDED FOR THIS TYPE OF MEASUREMENT
11. REFER TO LOCATION (A) (B) (C) AND (D) ON THIS TROUBLESHOOTING CHART
12. CABLE PWB MUST BE CONNECTED Q1100 COLLECTOR BIAS RESISTOR R1026 IS ON TRUNK/COMMAND BOARD.

RADIO SYSTEM TROUBLESHOOTING CHARTS

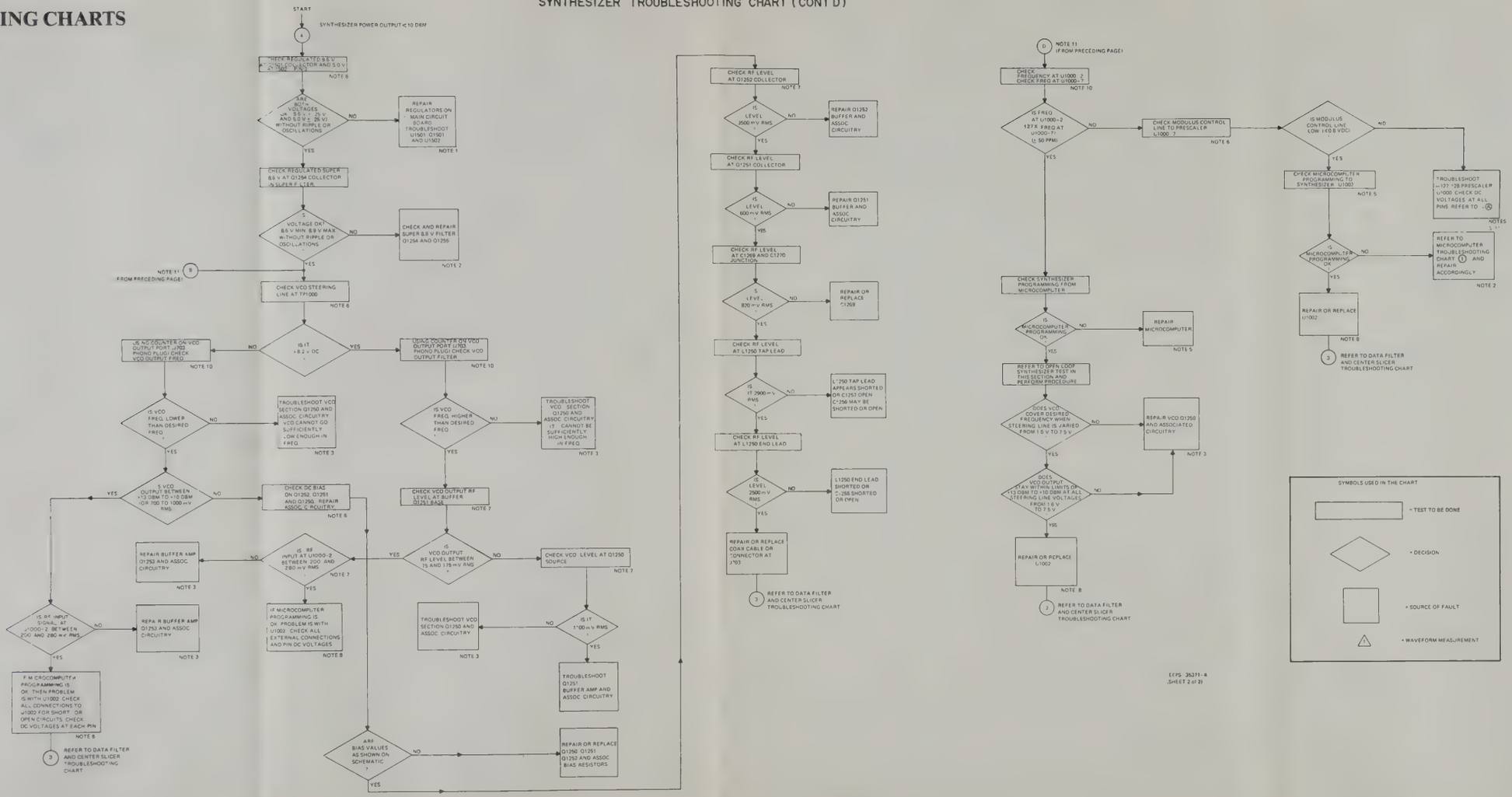
RADIO SYSTEM TROUBLESHOOTING CHARTS

DOUBLER/BUFFER/T-R SWITCH

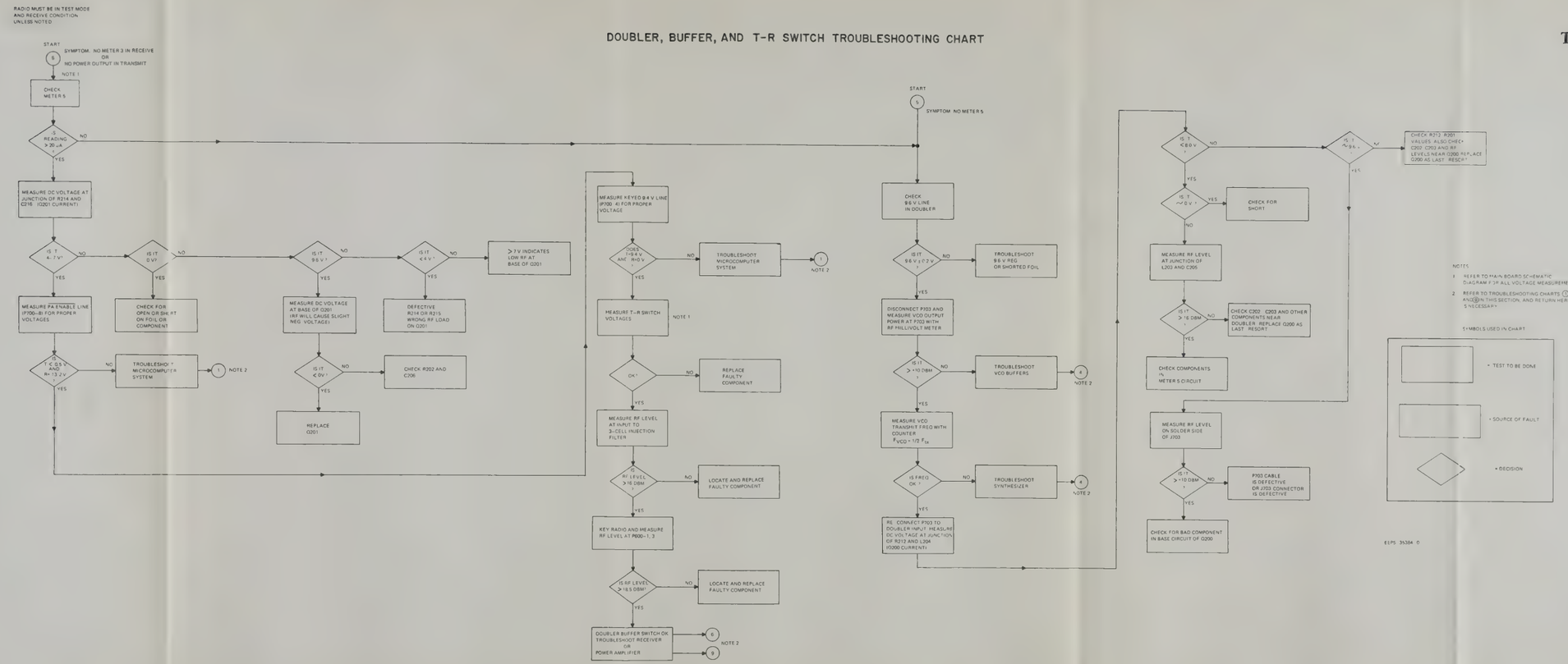


RADIO SYSTEM TROUBLESHOOTING CHARTS

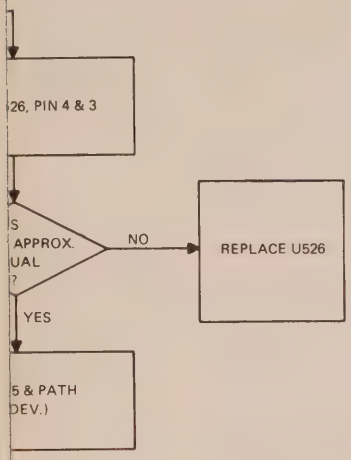
SYNTHESIZER (CONT'D.)

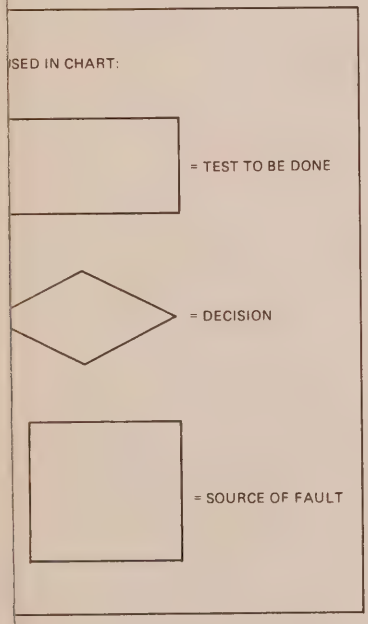


DOUBLER, BUFFER, AND T-R SWITCH TROUBLESHOOTING CHART



RADIO SYSTEM TROUBLESHOOTING CHARTS





AIN BOARD SCHEMATIC DIAGRAM.

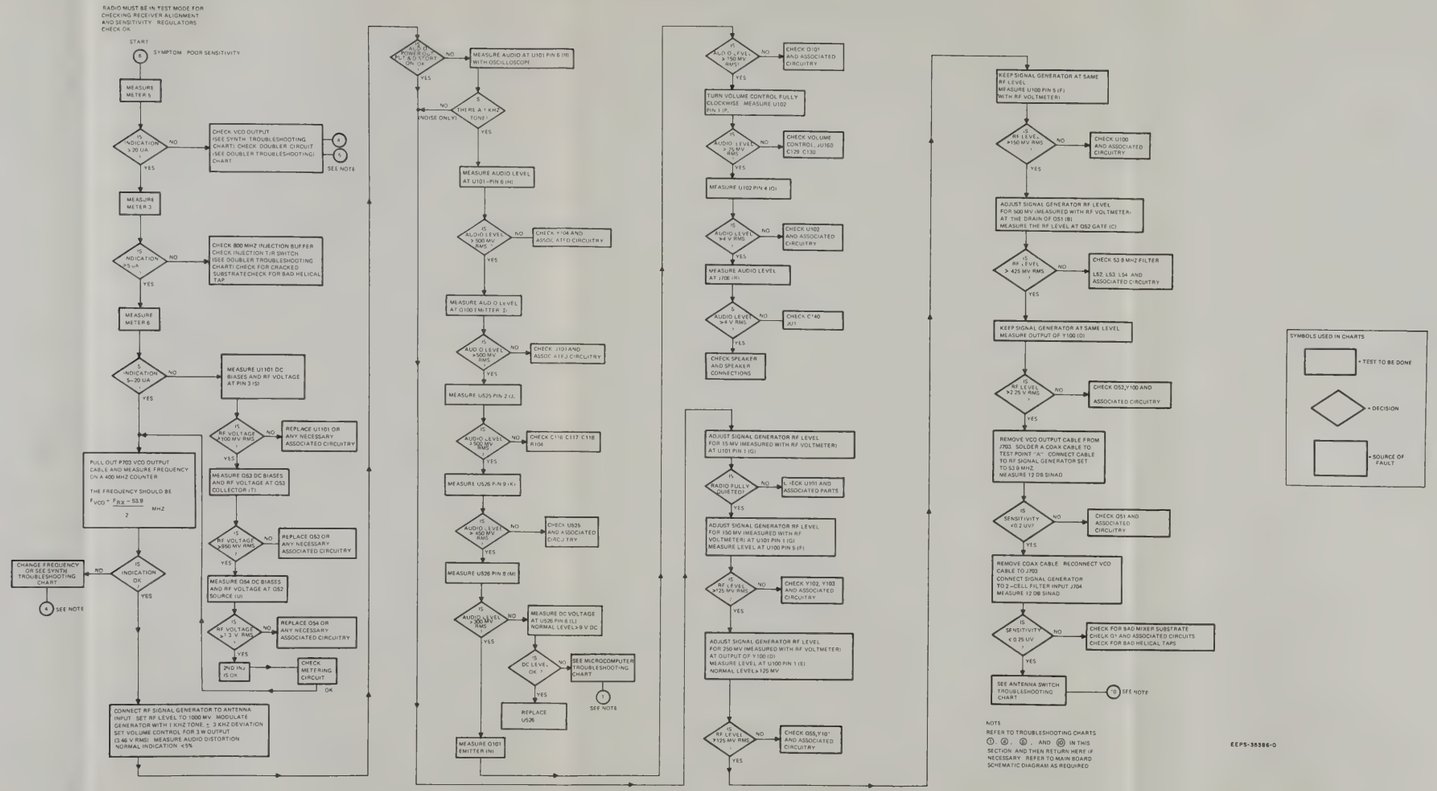
ROUBLESHOOTING CHART (4) IN THIS
D RETURN HERE IF NECESSARY.

RUNKED/COMMAND BOARD SCHEMATIC

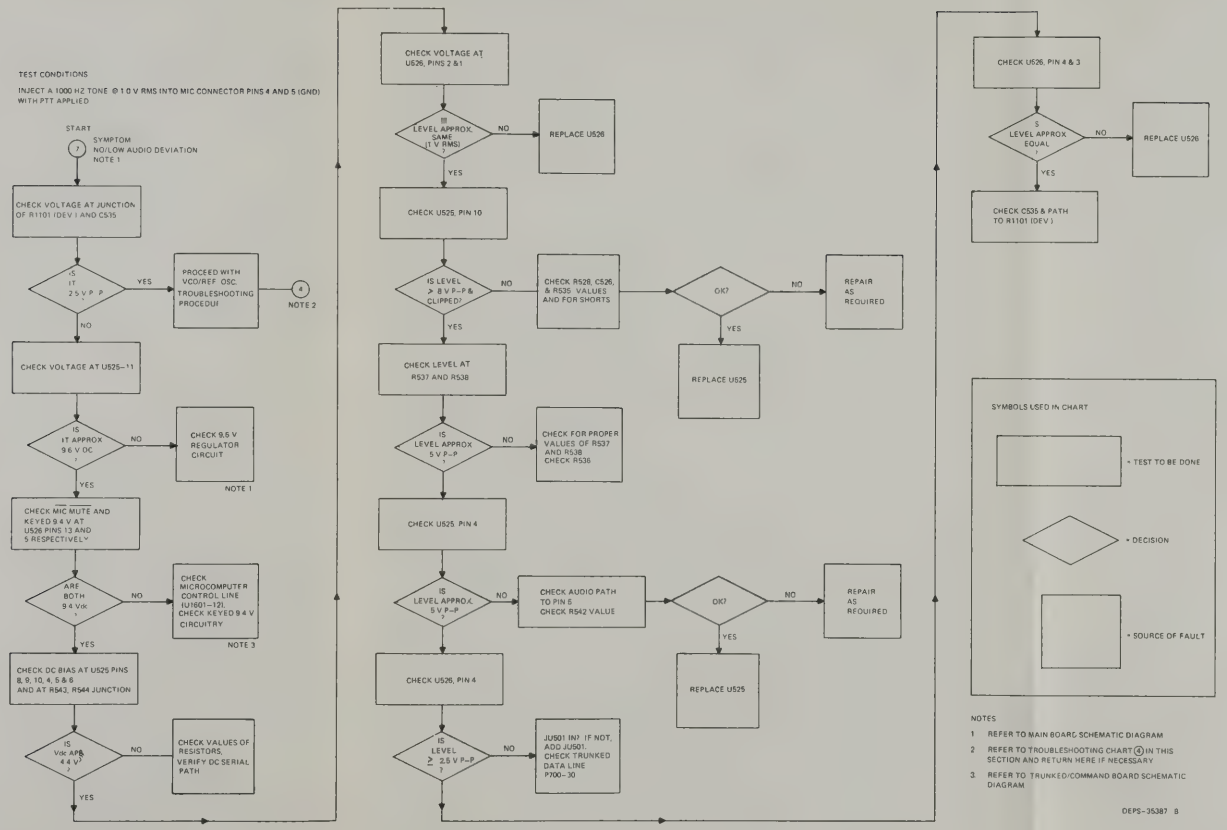
DEPS–35387- B

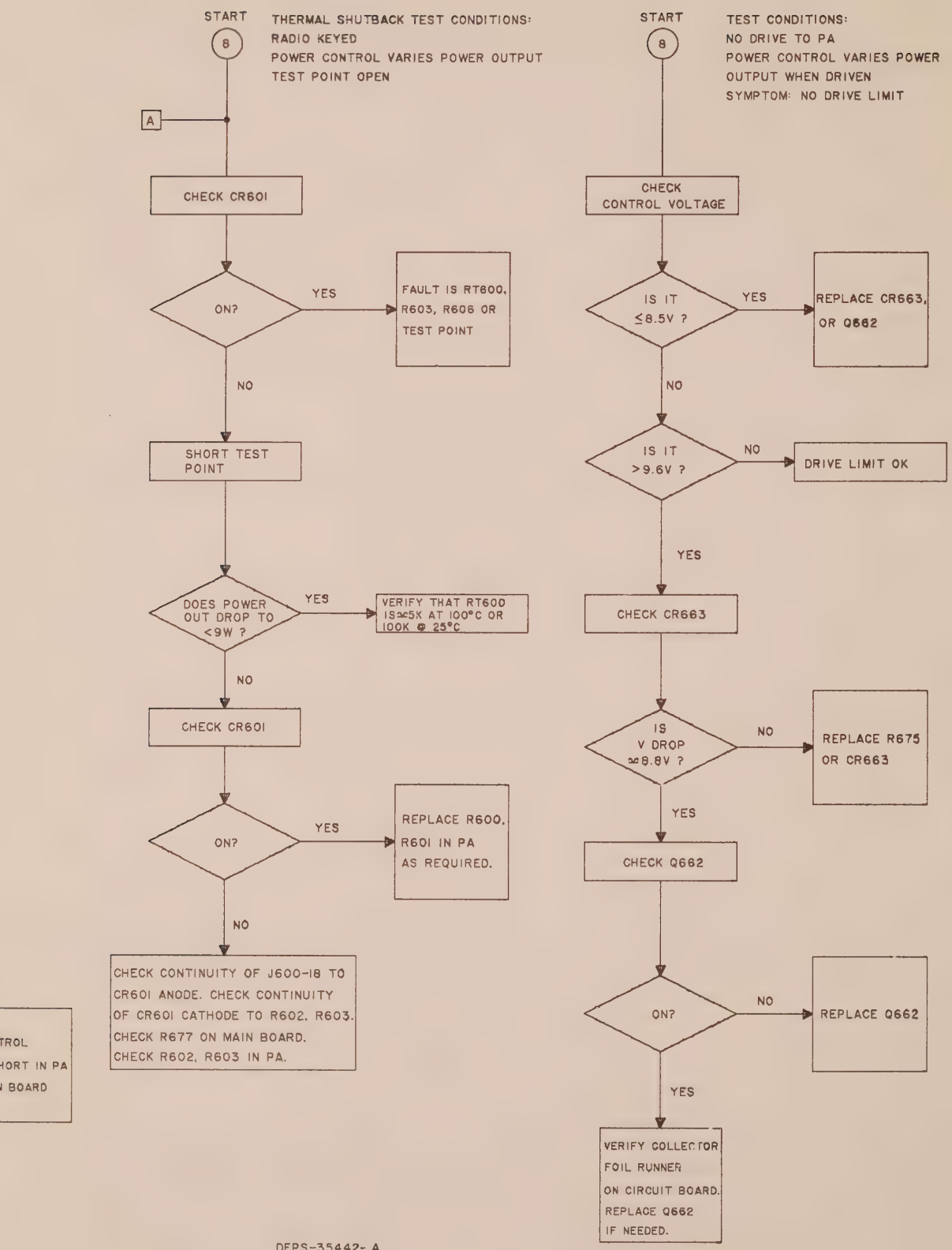
RADIO SYSTEM TROUBLESHOOTING CHARTS

RECEIVER



TRANSMIT AUDIO TROUBLESHOOTING CHART



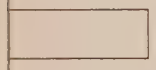


DEPS-35442-A
(SHEET 1 OF 2)

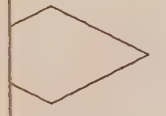
RADIO SYSTEM TROUBLESHOOTING CHARTS

POWER CONTROL (CONT'D.)

S USED IN CHART:



= TEST TO BE DONE



= DECISION

= SOURCE OF FAULT

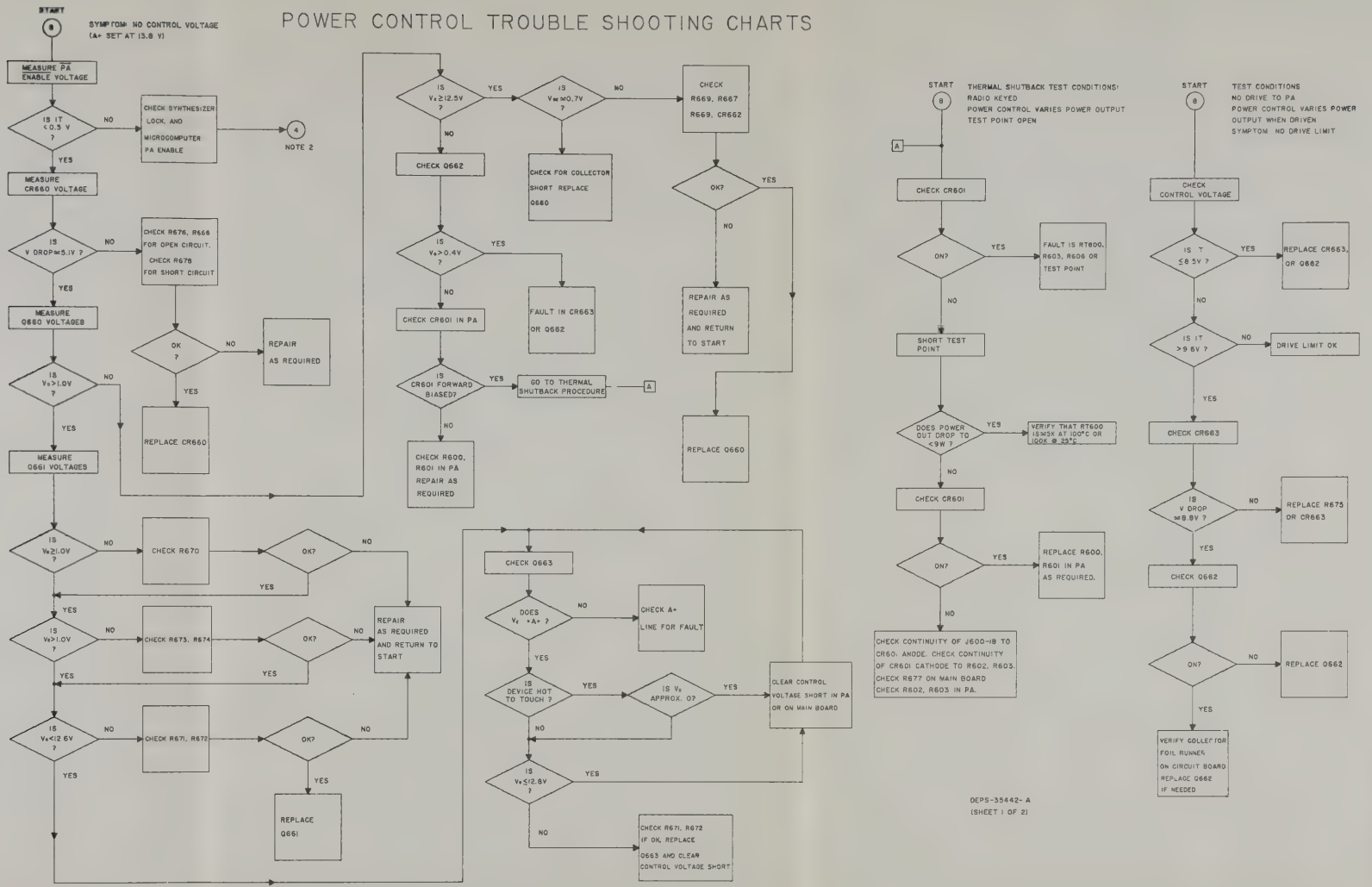
FER TO MAIN BOARD SCHEMATIC
GRAM FOR ALL VOLTAGE MEASUREMENTS.

FER TO TROUBLESHOOTING CHART
) IN THIS SECTION, AND RETURN
RE IF NECESSARY.

RADIO SYSTEM TROUBLESHOOTING CHARTS

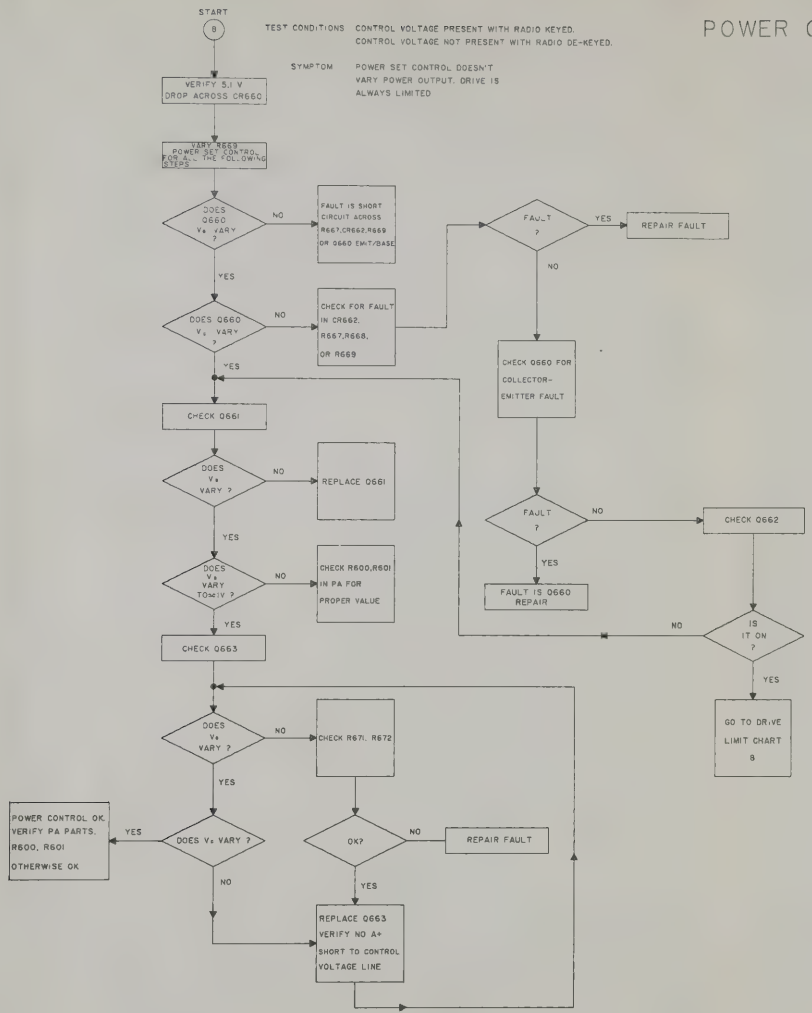
POWER CONTROL

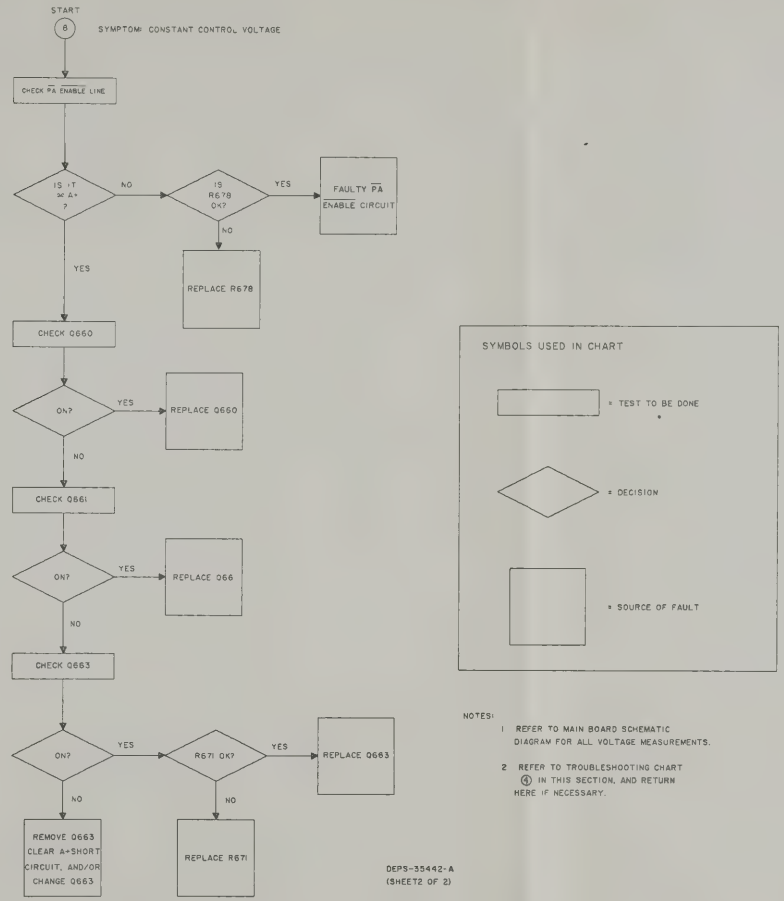
POWER CONTROL TROUBLE SHOOTING CHARTS



DEPS-35442-A
(SHEET 1 OF 2)

POWER CONTROL TROUBLE SHOOTING CHARTS (CONT'D.)

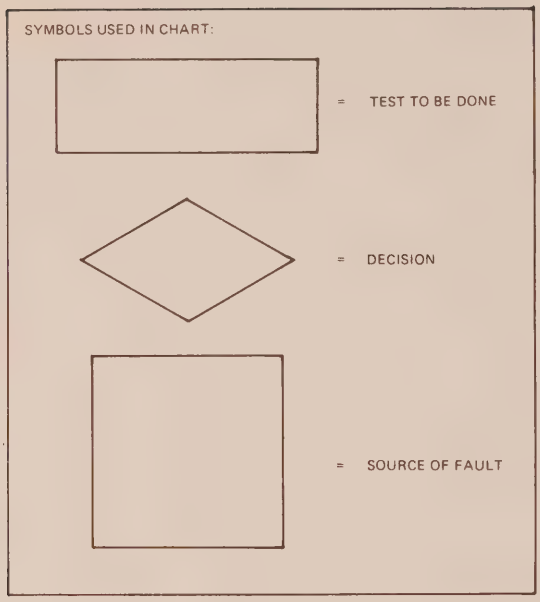




NOTES:

1. REFER TO MAIN BOARD SCHEMATIC DIAGRAM FOR ALL VOLTAGE MEASUREMENTS.
2. REFER TO TROUBLESHOOTING CHART (4) IN THIS SECTION, AND RETURN HERE IF NECESSARY.

DEPS-35442-A
(SHEET2 OF 2)



YES

CHECK IPA CIRCUIT FOR DC SHORT

NO

REPAIR AS REQUIRED

KEY RADIO AND MEASURE RADIO CURRENT DRAIN

IS IT BETWEEN 4.6- 7.5 A ?

NO

TEST U600 PER PROCEDURE IN TEXT, GO TO ANTENNA SWITCH TROUBLE-SHOOTING CHART (10) TO VERIFY U600 IS OK. REPLACE IF DEFECTIVE.

YES

DEKEY, REMOVE A+ AND UNSOLDER PIN 5 OF U600 PER PROCEDURE IN TEXT AND CHECK PIN 5 OF U600

IS PIN 5 CONNECTED TO U600?

NO

REPLACE U600.

YES

TEST U600 PER PROCEDURE IN TEXT. IF OK, RESOLDER PIN 5 OF U600. GO TO ANTENNA SWITCH TROUBLESHOOTING CHART (10)

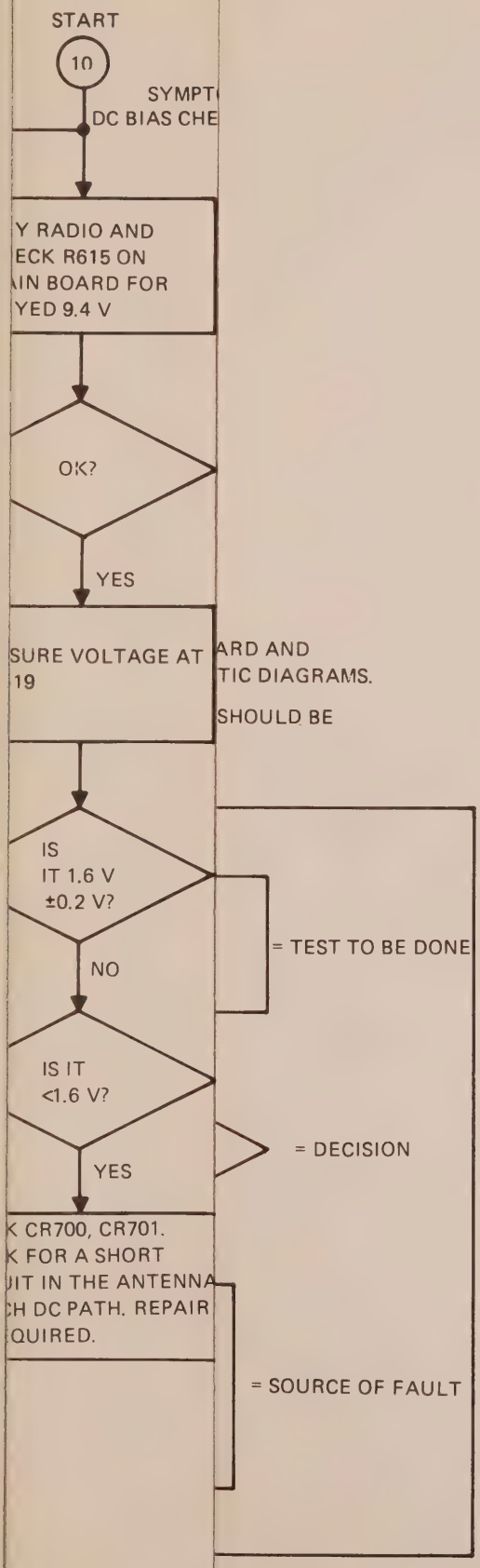
NOTE:

BE SURE TO MEASURE AT POINT WHERE PIN ENTERS MODULE, USING THE MODULE GROUNDING STRAP (ON PCB) FOR RF GROUND. A MORE ACCURATE MEASUREMENT METHOD IS DESCRIBED IN THE IPA/ MODULE MEASUREMENT SECTION.

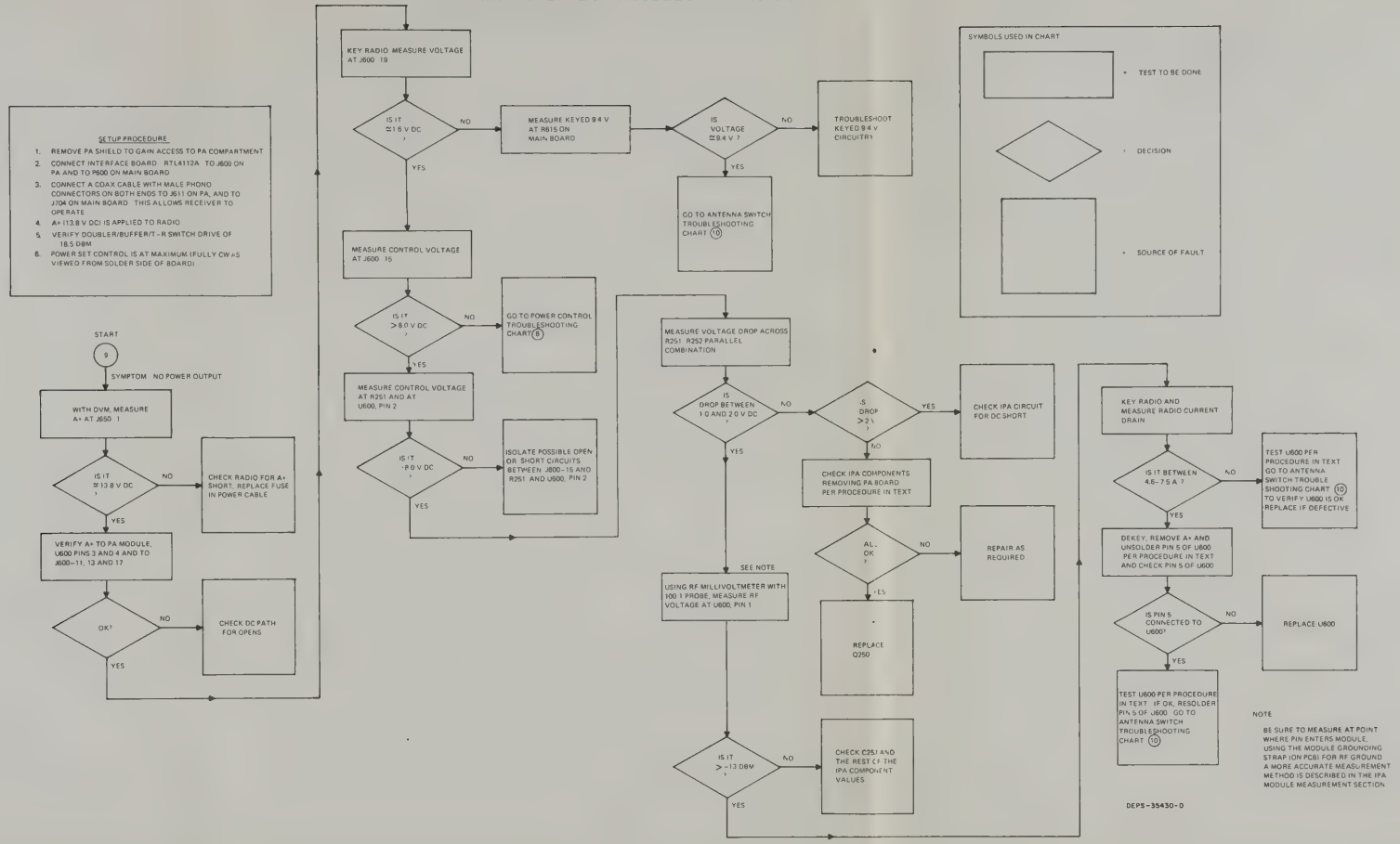
DEPS-35430-0

RADIO SYSTEM TROUBLESHOOTING CHARTS

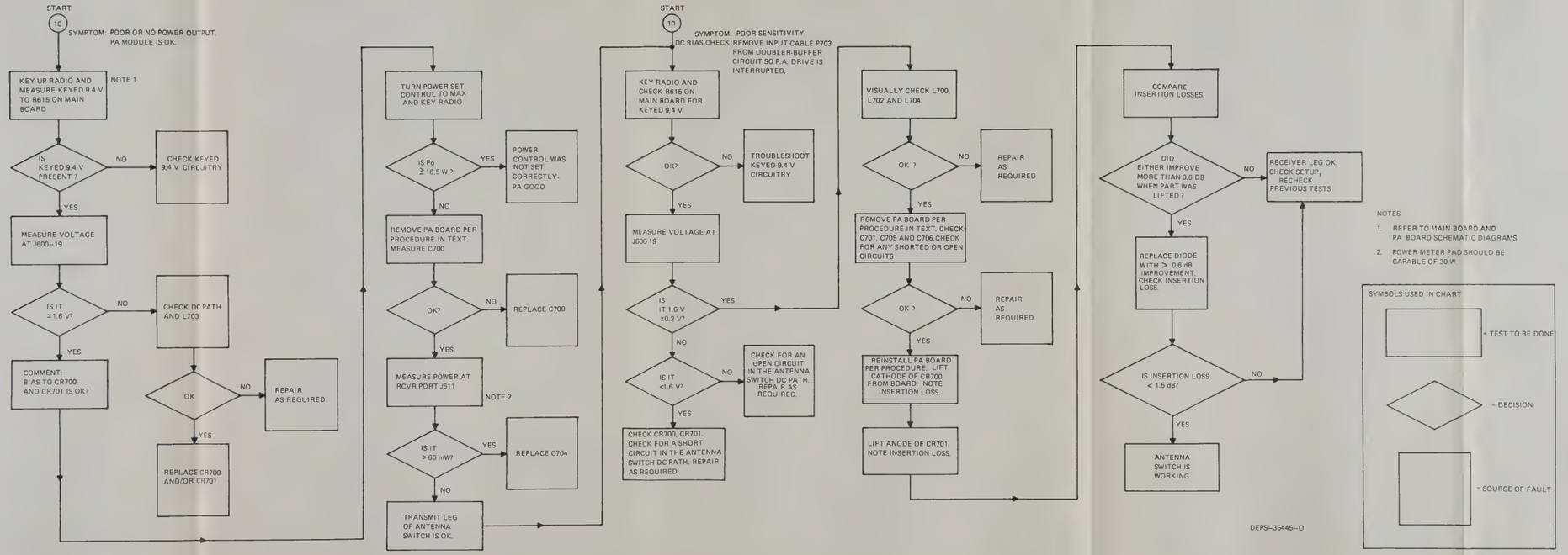
ANTENNA SWITCH



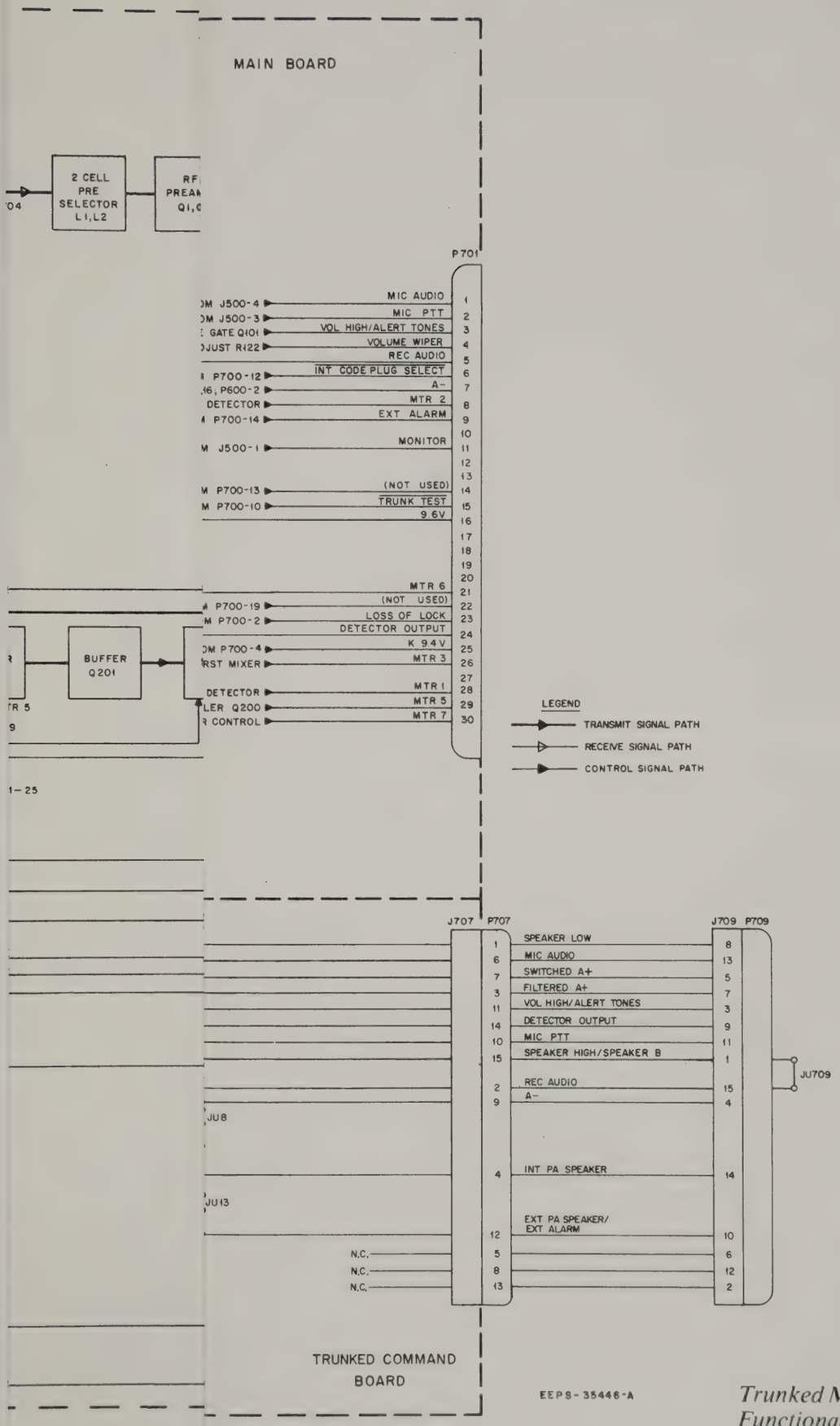
POWER AMPLIFIER TROUBLESHOOTING CHART



ANTENNA SWITCH TROUBLESHOOTING CHARTS



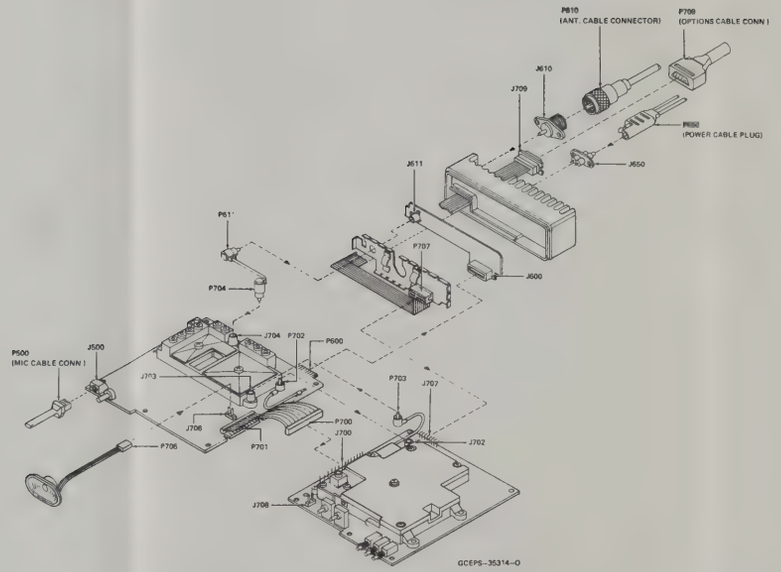
FUNCTIONAL INTERCONNECT DIAGRAM



EEPS-35446-A

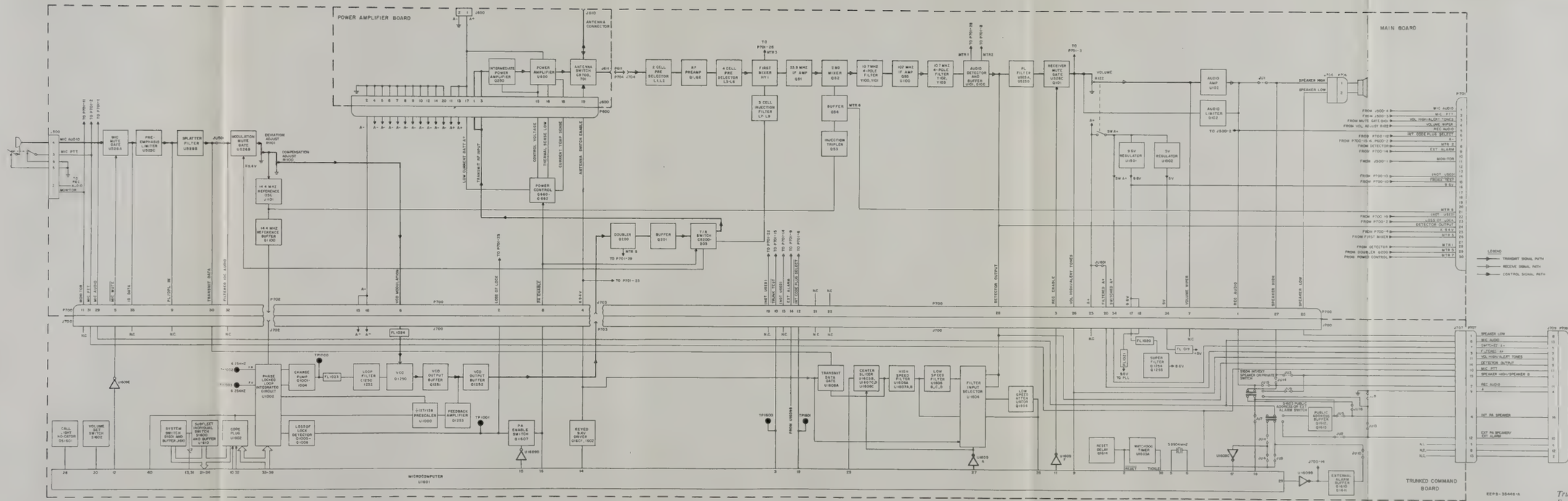
Trunked Mostar Radio Set
Functional Interconnect Diagram
Motorola No. EEPS-35446-A
2/10/84-PHI

RADIO SET
CONNECTOR LOCATION DETAIL



Trunked Mostar Radio Set
Connector Location Detail
Motorola No. GCEPS-35314-O
12/31/82-PHI

FUNCTIONAL INTERCONNECT DIAGRAM

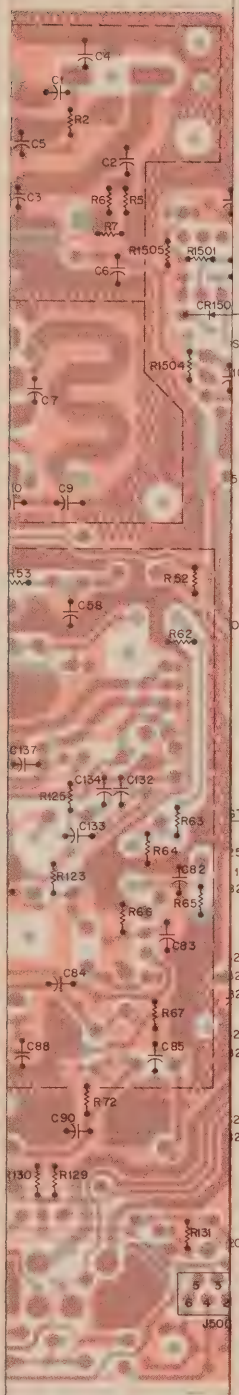


EEPS-35446-A

Trunked Master Radio Set
Functional Interconnect Diagram
Motorola No. EEPS-35446-A
2 10 84 PHI

MAIN BOARD

SCHEMATIC DIAGRAM, CIRCUIT
BOARD DETAILS, AND PARTS LIST
MODEL HLF4063B



STOR LEAD DETAILS

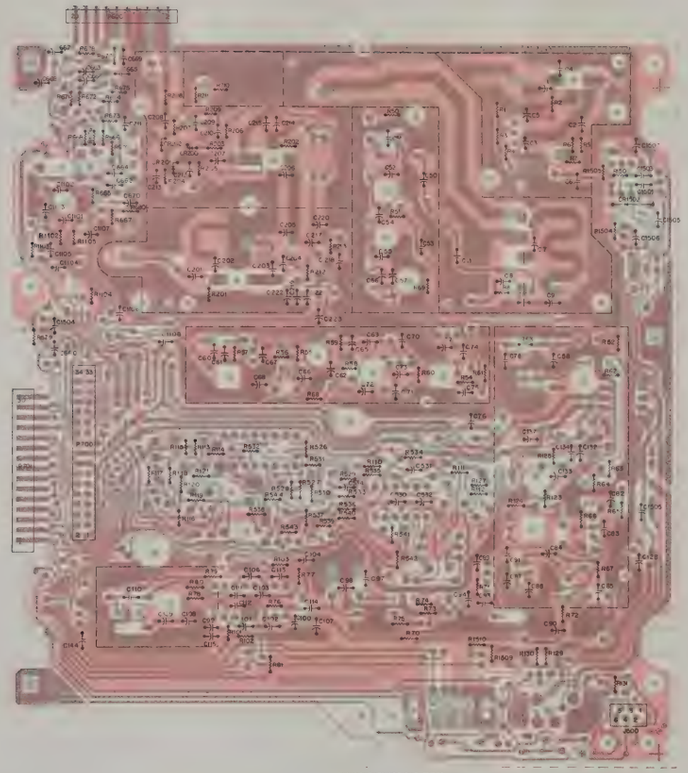
2510	(Q200)
137	(Q201)
3216	(Q1)
204	(Q53,Q54)
3208	(Q100,Q101,Q661,Q662,Q1502)
3209	(Q2,Q102,Q660)
218	(Q55)
221	(Q51,Q52)
210	(Q663)
215	(Q1501)
201	(Q1100)

MAIN BOARD

68P81063E42-B
(Sheet 1 of 3)
2/10/84-PHI

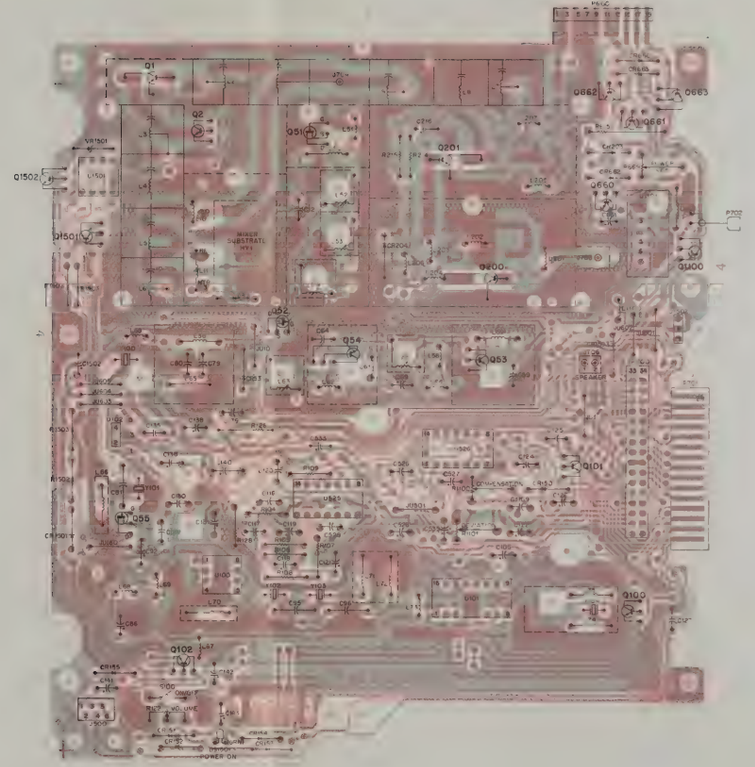
MAIN BOARD

SCHEMATIC DIAGRAM, CIRCUIT BOARD DETAILS, AND PARTS LIST
MODEL HLF4063B



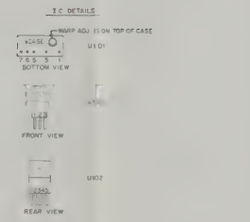
SOLDER SIDE VIEW

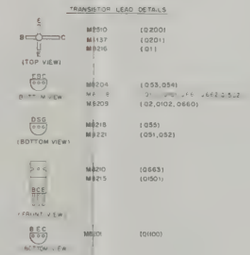
(COMPONENTS ARE CHIP TYPE)
- COMPONENT SIDE EEPS-35480-A (REVERSED)
- SOLDER SIDE EEPS-35481-A
- OL EEPS-35463-A

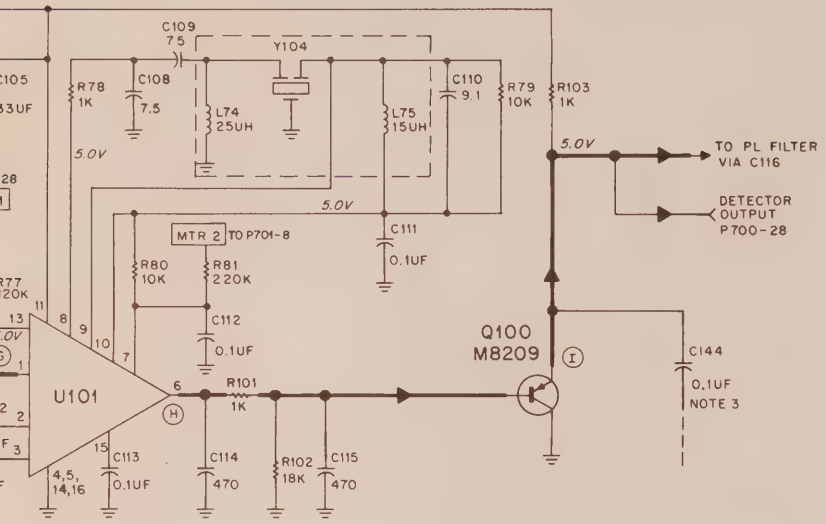


COMPONENT SIDE VIEW

- COMPONENT SIDE EEPS-35460-A
- SOLDER SIDE EEPS-35461-A (REVERSED)
- OL EEPS-35462-B







TO
T MIXER
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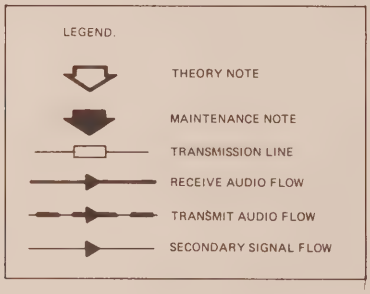
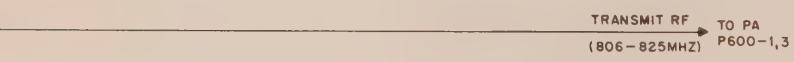
RECEIVE





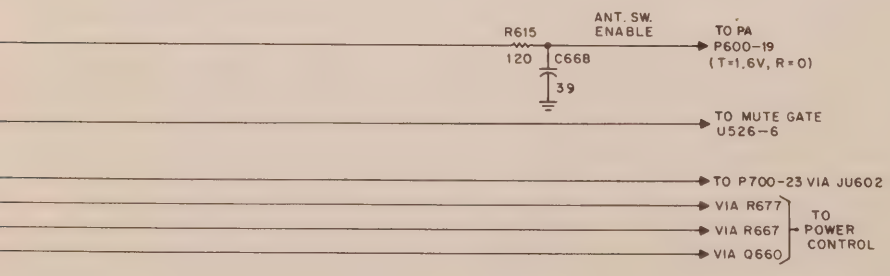
OUT
TD

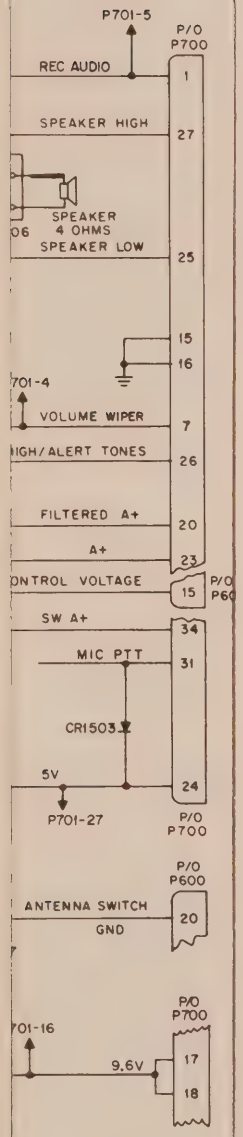
IAL FUNCTION
ERED A+ OPT.

NOTES

1. UNLESS OTHERWISE INDICATED, RESISTOR VALUES ARE IN OHMS, CAPACITOR VALUES ARE IN PICOFARADS, AND INDUCTOR VALUES ARE IN NANOHENRIES. FOR COLOR CODED INDUCTORS, REFER TO PARTS LIST FOR INDUCTOR DESCRIPTION.
2. DC VOLTAGES SHOWN ARE REFERENCED TO A-
3. C144 FOR FUTURE USE.
4. SYMBOLS INDICATED AS (J) ETC., REFER TO SYMBOLS WITHIN "TEST" BOXES ON RECEIVER TROUBLESHOOT CHART (6)

EEPS-35145-B
(SHEET 1 OF 2)





TED, RESISTOR VALUES ARE
ES ARE IN PICOFARADS, AND
NANOHENRIES. FOR COLOR
TO PARTS LIST FOR INDUCTOR

REFERENCED TO A–.

) ETC., REFER
BOXES ON
CHART ⑥

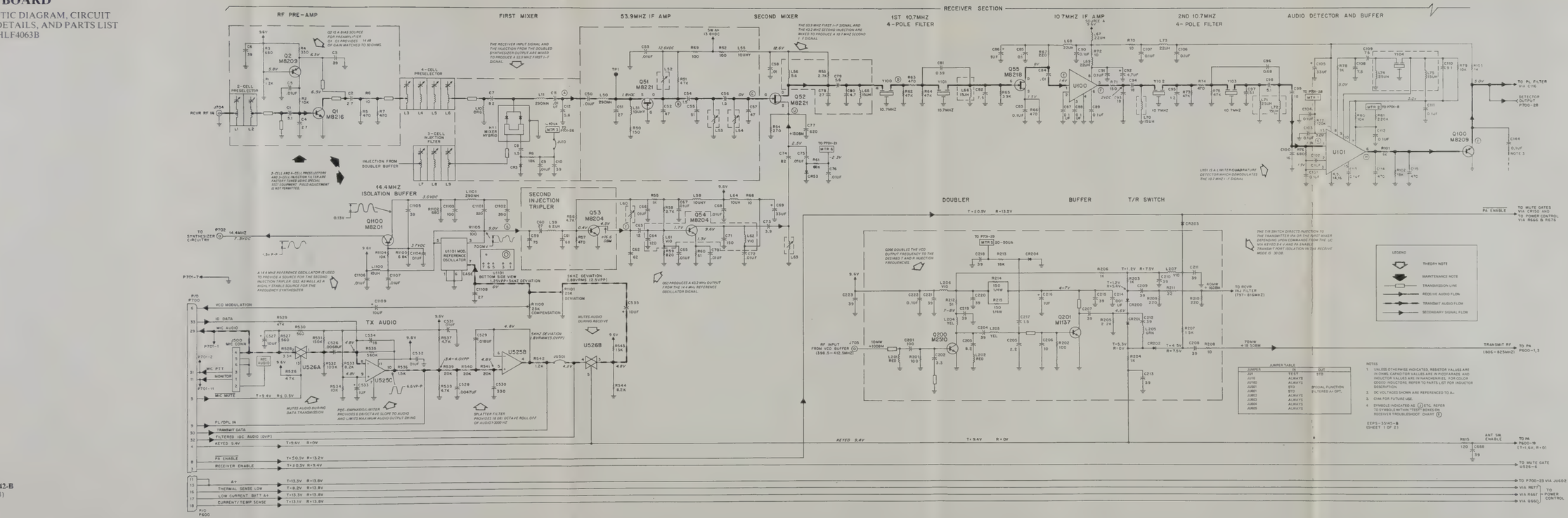
ERNAL

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
R527	6-11024A43	560
R528	6-11024A61	3.3k
R529	6-11024A89	47k
R530	6-11024A43	560
R531	6-11024B02	150k
R532	6-11024A97	100k
R533	6-11024A71	8.2k
R534	6-11024A73	10k
R535	6-11024B16	560
R536	6-11024A53	1.5k
R537, 538	6-11024A65	4.7k
R539, 540, 541	6-11024A80	20k
R542	6-11024A51	1.2k
R543	6-11024A77	15k
R544	6-11024A71	8.2k
R615	17-80290D01	ww 120 ± 10%; 2 W
R665	6-11024A79	18k
R666	6-11024A51	1.2k
R667	6-11024A49	1k
R668	6-11024A71	8.2k
R669	18-80087E01	variable; 25k
R670	6-11024A33	220
R671	6-11024A43	560
R672	6-11024A25	100
R673, 674	6-11024A37	330
R675	6-11024A25	100
R676	6-11024A51	1.2k
R677	6-11024A35	270
R678	6-11024A57	2.2k
R679	6-11024B06	220k
R680	6-11024A71	8.2k
R681	6-11024A31	180
R1100, 1101	18-80087E01	variable; 25 V
R1102	6-11024A45	680
R1103	6-11024A69	6.8k
R1104	6-11024A73	10k
R1105	6-11024A25	100
R1501	6-11024A73	10k
R1502	6-10621C18	1.74k ± 1%; FMF
R1503	6-10621C28	2.21k ± 1%; FMF
R1504	6-11024A45	680
R1505	6-11024A51	1.2k
R1506	6-11024A45	680
R1507, 1508	6-11029A49	150; 1/4 W
R1509, 1510	6-11024A47	820
		integrated circuit: (see note)
U100	51-80066C02	I-F Amplifier
U101	51-80069C05	I-F/Audio Special
U102	51-80065C09	Audio Amplifier
U525	51-80067C06	Quad Op Amplifier
U526	51-80073C05	Trans Gate
U1101	51-80291B01	Oscillator
U1501	51-80067C09	Op Amplifier
U1502	51-80068C02	Voltage Regulator; 5 V
		voltage regulator:
VR600	48-80007E01	Zener type; 5.1 V
VR663	48-80007E03	Zener type; 8.8 V
VR1501	48-83461E40	Zener type; 5.2 V
		crystal: (see note)
Y100	91-80011E04	10.7 MHz
Y101	91-80011E05	10.7 MHz
Y102, 103, 104	91-80011E05	10.7 MHz
		mechanical parts
	3-10943M11	SCREW, tapping; TT3 × 0.5 × 10; 9 used
	3-80136F01	SCREW, metric HI/LO; 5 used
	5-80000F01	GROMMET; 5 used
	15-80038E01	COVER, mixer
	15-80039E01	COVER, filter; bottom
	15-80040E01	COVER, buffer doubler
	26-80142E01	SHIELD, 10.7 MHz I-F bottom
	26-80143E01	SHIELD, quad
	26-80145E01	SHIELD, local oscillator
	32-80172F01	GASKET, rf deck cover
	32-80171F01	GASKET, rf deck
	26-80049F01	SHIELD, can; 3 used
	26-80049F02	SHIELD, can
	26-80144E01	SHIELD, I-F
	26-80237E01	SHIELD, xtal
	43-80218E01	SPACER, mounting Q663, 1501, U102, 1502
	2-80080D01	NUT, tension; 9 used
	3-80079D01	SCREW, set filter; 9 used
	15-80034E02	COVER, 2-cell
	15-80035E02	COVER, 3-cell
	15-80036E02	COVER, 4-cell
	15-80033E01	HOUSING, 800 mH filter

note: For optimum performance, diodes, transistors, and integrated circuits must be ordered by Motorola part numbers.

MAIN BOARD

SCHEMATIC DIAGRAM, CIRCUIT BOARD DETAILS, AND PARTS LIST
MODEL HLF4063B



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(Sheet 2 of 3)
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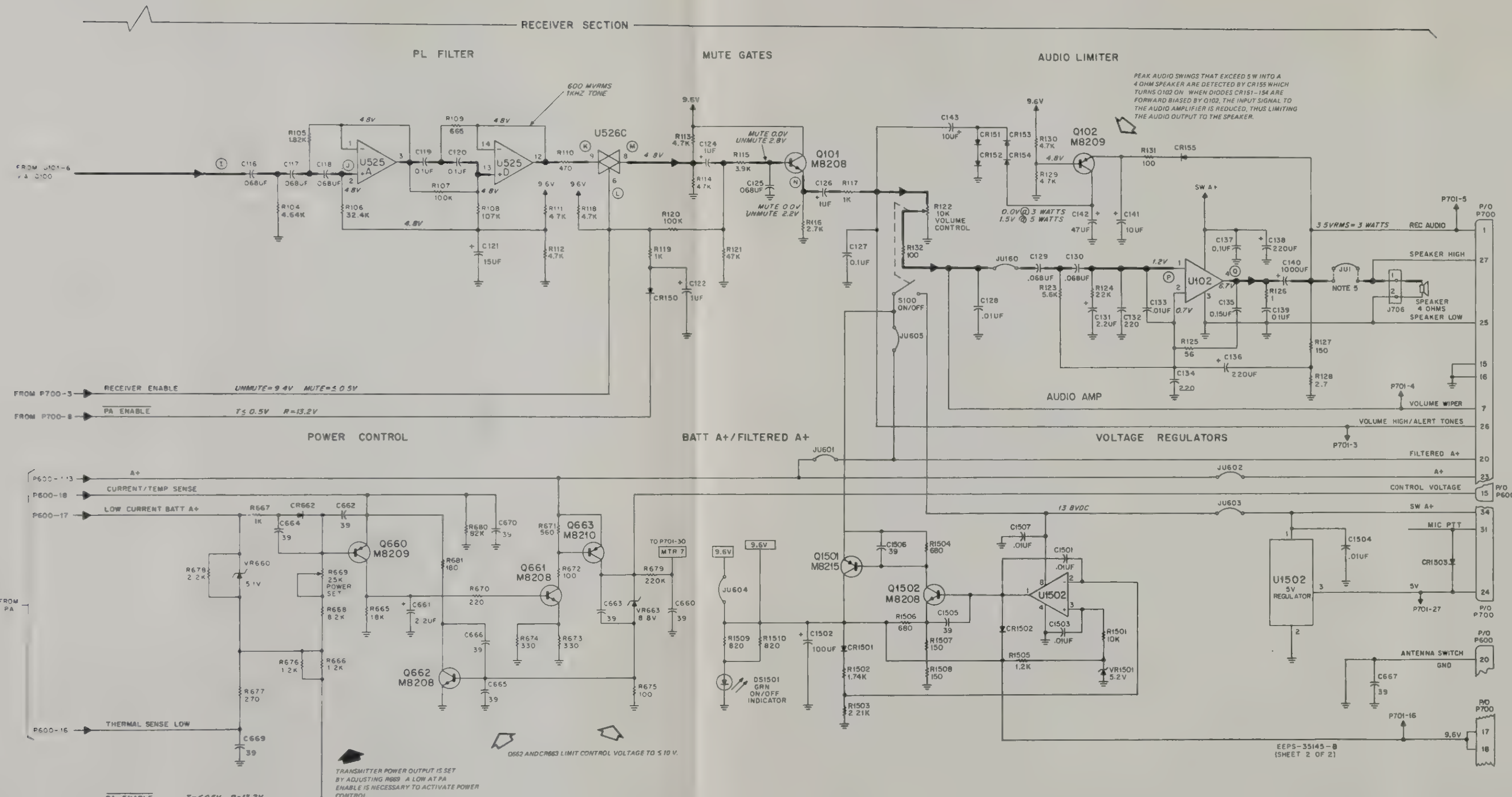
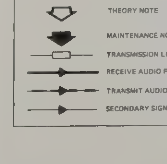




JUMPER TABLE

JUMPER	IN	OUT
JU1	TEST	STD
JU10	ALWAYS	
JU160	ALWAYS	
JU501	STD	SPECIAL FUNCTION
JU601	STD	FILTERED A+ OPT
JU602	ALWAYS	
JU603	ALWAYS	
JU604	ALWAYS	
JU605	ALWAYS	

NOTES

1. UNLESS OTHERWISE INDICATED, RESISTOR VALUES ARE IN OHMS, CAPACITOR VALUES ARE IN PICOFARADS, AND INDUCTOR VALUES ARE IN NANOHENRIES. FOR COLOR CODED INDUCTORS, REFER TO PARTS LIST FOR INDUCTOR DESCRIPTION.
2. DC VOLTAGES SHOWN ARE REFERENCED TO A–.
3. C144 FOR FUTURE USE.
4. SYMBOLS INDICATED AS (J) ETC., REFER TO SYMBOLS WITHIN "TEST" BOXES ON RECEIVER TROUBLESHOOT CHART (8).
5. JU1 IS USED ONLY FOR INTERNAL SPEAKER AUDIO TESTING.

parts list

HLF4063B Main Board PL-8314-B

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		capacitor, fixed; pF ± 5%: 50V; unless otherwise stated
C1	21-11031A62	5.1 ± 0.5 pF; chip
C2	21-11031A06	2.7 ± 0.25 pF; chip
C3	21-11031A29	39; chip
C4	21-11031A06	2.7 ± 0.25 pF; chip
C5	21-11032B07	.01 uF + 80 – 20%; chip
C6	21-11031A29	39; chip
C7	21-11031A13	8.2 ± 0.5 pF; chip
C8	21-11031A03	1.5 ± 0.25; chip
C9	21-11032B07	.01 uF + 80 – 20%; chip
C10	21-11031A29	39; chip
C11	21-11032B07	.01 uF + 80 – 20%; chip
C12	21-11038A19	5.6 ± 0.5 pF; disc
C50	21-11032B07	.01 uF + 80 – 20%; chip
C51	21 11031A25	27, chip
C52	21 11031A31	47 chip
C53	21-11032B07	01 uF + 80 – 20%; chip
C54	21-11031A03	1.5 ± 0.25 pF, chip
C55	21-11031A32	51; chip
C56	21-11031A03	1.5 ± 0.25 pF; chip
C57	21-11031A31	47; chip
C58	21-11032B07	.01 uF + 80 – 20%; chip
C59	21-11038A46	75; disc
C60	21-11031A25	27; chip
C61	21-11031A35	68; chip
C62	21-11031A34	62; chip
C63	21-11031A17	12; chip
C64	21-11038A51	120; disc
C65 thru 68	21-11032B07	.01 uF + 80 – 20%; chip
C69	23-11019A33	33 uF ± 20%; 25 V
C70	21-11032B07	.01 uF + 80 – 20%; chip
C71	21-11031A43	150; chip
C72	21-11032B07	.01 uF + 80 – 20%; chip
C73	21-11031A08	3.9 ± 0.25 pF; chip
C74	21-11031A37	82; chip
C75, 76	21-11032B07	.01 uF + 80 – 20%; chip
C77	21-11031A58	620; chip
C78	21-11031A25	27; chip
C79	21-11038A19	5.6 ± 0.5 pF; disc
C80	21-11038A17	4.7 ± 0.25 pF; disc
C81	21-80292D06	0.39 uF; 500 V
C82	21-11031A12	7.5 ± 0.5 pF; chip
C83	21-11032B13	0.1 uF + 80 – 20%; chip
C84	21-11032B07	.01 uF + 80 – 20%; chip
C85	21-11032B13	0.1 uF + 80 – 20%; chip
C86	23-11019A09	1 uF ± 20%
C87 thru 91	,21-11032B13	0.1 uF + 80 – 20%; chip
C92	23-11013D55	4.7 uF ± 20%; 20 V
C93, 94	21-11031A21	18; chip
C95	21-80292D10	1.2 uF, 500 V
C96	21-80292D11	0.68 uF, 500 V
C97, 98	21-11031A62	5 1 ± 0.5 pF; chip
C99	21-11031A21	18; chip
C100	21-11031A20	16; chip
C101 thru 104	21-11032B13	0.1 uF + 80 – 20%; chip
C105	23-11019A33	33 uF ± 20%, 25 V
C106, 107	21-11032B13	0.1 uF + 80 – 20%; chip
C108, 109	21-11031A12	7.5 ± 0.5 pF; chip
C110	21-11031A14	9.1 ± 0.5 pF; chip
C111 112, 113	21 11032B13	0 1 uF + 80 – 20% chip
C114, 115	21-11031F55	470; chip
C116, 117, 118	8-11017A16	.068 uF ± 5%
C119, 120	8-11017A17	0.1 uF
C121	23-11019A50	15 uF ± 20%; 25 V
C122	23-11019A09	1 uF ± 20%
C124	23-11019A09	1 uF ± 20%
C125	8-11017A17	.068 uF
C126	23-11019A09	1 uF ± 20%
C127	8-11017A17	0.1 uF
C128	21-11032B07	.01 uF + 80 – 20%; chip
C129, 130	8-11017A16	.068 uF
C131	23-11019A11	2.2 uF ± 20%
C132	21-11031A47	220; chip
C134	21-11031A47	220; chip
C135	8-11023A27	0 15 uF
C136	23-11037A66	220 uF ± 20%; 35 V
C137	21-11032B13	0.1 uF + 80 – 20%; chip
C138	23-11037A66	220 uF ± 20%; 35 V
C139	8-11017A17	0.1 uF
C140	23-80271E01	1000 uF
C141	23-11019A20	10 uF ± 20%; 25 V
C142	23-11019A40	47 uF ± 20%, 25 V
C143	23-11019A20	10 uF ± 20%; 25 V
C144	21-11032B13	0.1 uF + 80 – 20%
C201	21-11031A39	100; chip
C202	21-11031A07	3.3 ± 0.25 pF; chip
C203	21-11031A13	8.2 ± 0.5 pF; chip
C204	21-11031A29	39; chip
C205	21-11031A05	2.2 ± 0.25 pF; chip
C206	21-11031A15	10 ± 0.5 pF; chip
C207 thru 213	21-11031A29	39;chip
C214	21-11032B01	.001 uF + 80-20%; chip
C215	21-11031A29	39;chip
C216	23-11019A09	1 uF ± 20%
C217	21-11031A03	1.5 ± 0 25 pF; chip

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
C218 thru 221	21-11031A29	39; chip
C222	21-11032B13	0.1 uF + 80 – 20%, chip
C223	21-11031A29	39;chip
C526	8-11017A07	0068 uF
C527	23-11019A20	10 uF ± 20%; 25 V
C528	8-11017A06	0047 uF
C529	8-11017A10	018 uF
C530	21-11031A51	330; chip
C531, 532	21-11032B07	01 uF + 80 – 20%; chip
C533	23-11019A09	1 uF ± 20%
C534	21-11031A21	18
C535	23-11019A20	10 uF ± 20%; 25 V
C660	21-11031A24	39; chip
C661	23-11019A11	2.2 uF ± 20%
C662 thru 668	21-11031A29	39; chip
C669 670	21 11031A29	39 chip
C1101	21 11031A47	220 + 80 20%; chip
C1102	21-11031A53	390; chip
C1103	21-11031A39	100; chip
C1104	21-11032B13	0.1 uF + 80 – 20%; chip
C1105	21-11031A29	39; chip
C1106, 1107	21-11032B07	.01 uF + 80 – 20%; chip
C1108	21-11031A25	27; chip
C1109	23-11019A20	10 uF ± 20%; 25 V
C1501	21-11032A21	.01 uF + 80 – 20%; chip
C1502	23-11019A46	100 uF ± 20%, 25 V
C1503	21-11032A21	01 uF + 80-20%, chip
C1504	21-11032B07	.01 uF + 80 – 20%; chip
C1505, 1506	21-11031A29	39; chip
C1507	21-11032A21	.01 uF + 80 – 20%; chip
		diode: (see note)
CR3	48-80012E01	Hot carrier
CR53	48-80005E01	silicon
CR150 thru 155	48-80005E01	silicon
CR200, 201, 202	48-80013E02	silicon
CR203	48-80005E01	silicon
CR204	48-80012E01	Hot carrier
CR622	48-80005E01	silicon
CR1501	48-83654H02	silicon
CR1502, 1503	48-80005E01	silicon
		light emitting diode: (see note)
DS1501	48-80159E07	green
		hybrid:
HY1	1-80724D26	mixer PH shift
		connector, receptacle:
J500	9-80145D01	female, 6 contact
J703, 704		consists of:
	15-80174F01	HOUSING, rf connector
	15-80175F01	COVER, rf connector
	39-80065F01	CONTACT, rf connector
J706	28-80085E05	male, 2 contact
		jumper, resistor:
JU10	6-11009B23	1; 1/4 W
JU160	6-11009B23	1; 1/4 W
JU501	6-11009B23	1; 1/4 W
JU601 thru 605	6-11009B23	1; 1/4 W
		coil, rf:
L1 thru 9		p/o rf deck not repairable
L10	24-11030E03	1/2 turns; org
L11	24-80002E02	290 nH
L50	24-80002E02	290 nH
L51	24-80044F01	choke; 10 uH
L52	24-80094F01	tunable
L53, 54	24-80094E01	tunable
L55	24-80044F01	choke, 10 uH
L56	24-80294D03	choke; 5.6 uH
L58	24-80044F01	choke; 10 uH
L59	24-80002E04	choke; 6.2 uH
L60	24-80094E01	tunable
L61, 62	24-11030D06	7 turns; vio
L63	24-80094F01	tunable
L64	24-80044F01	choke; 10 uF
L65, 66	24-80002E12	choke, 15 uH
L67, 68, 69	24-80044F02	choke, 22 uH
L70	24-80002E12	choke; 15 uH
L71	24-80002E14	choke; 25 uH
L72	24-80002E12	choke, 15 uH
L73	24-80044F02	choke, 22 uH
L74	24-80002E14	choke; 25 uH
L75	24-80002E12	choke; 15 uH
L201, 202	24-11030D01	2-turns; red
L203, 204	24-11030D03	4-turns; yellow
L205	24-11030D04	5-turns; green
L206, 207	24-11030D06	7 turns, vio
L1100	24-80044F01	choke; 10 uH
L1101	24-80002E02	choke; 290 nH
		connector, plug:
P600		part of pc board
P700	30-80068D01	cable; flat includes connector
P701		part of pc board
P702	30-80031E01	cable, rf jumper; includes connector

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		transistor: (see note)
Q1	48-80182D16	NPN, type M8216
Q2	48-80182D09	PNP; type M8209
Q51, 52	48-80182D21	field-effect, type M8221
Q53, 54	48-80182D04	NPN, type M8204
Q55	48-80182D18	field-effect, type M8218
Q100	48-80182D09	PNP; type M8209
Q101	48-80182D08	PNP, type M8208
Q102	48-80182D09	PNP, type M8209
Q200	48-80225C10	NPN, type M2510
Q201	48-80225C08	NPN, type M2508
Q660	48-80182D09	PNP; type M8209
Q661, 662	48-80182D08	NPN, type M8208
Q663	48-80182D10	PNP, type M8210
Q1100	48-80182D01	PNP; type M8201
Q1501	48 80182D15	PNP, type M8215
Q1502	48 80182D08	NPN, type M8208
		resistor, fixed: chip ± 5%: 1/8 W; unless otherwise stated
R1	6-11024A51	1.2k
R2	6-11024A73	10k
R3	6-11024A45	680
R4	6-11024A37	330
R5	6-11024A41	470
R6	6-11024A01	10
R7	6-11024A41	470
R8	6-11024A79	18k
R50	6-11024A29	150
R51	6-11024A65	4.7k
R52	6-11024A25	100
R53	6-11024A59	2.7k
R54	6-11024A35	270
R55	6-11024A49	1k
R56	6-11024A65	4.7k
R57	6-11024A41	470
R58	6-11024A59	2.7k
R59	6-11024A47	820
R60	6-11024A18	51
R61	6-11024A93	68k
R62	6-11024A89	47k
R63	6-11024A41	470
R64	6-11024A89	47k
R65	6-11024A63	3.9k
R66	6-11024A41	470
R67	6-11024A33	220
R68	6-11024A01	10
R69	6-11024A25	100
R70	6-11024A01	10
R71	6-11024A29	150
R72	6-11024A01	10
R73	6-11024A89	47k
R74	6-11024A41	470
R75	6-11024A89	47k
R76	6-11024A45	680
R77	6-11024A99	120k
R78	6-11024A49	1k
R79, 80	6-11024A73	10k
R81	6-11024B06	220k
R101	6-11024A49	1k
R102	6-11024A79	18k
R103	6-11024A49	1k
R104	6-11049C59	4 64k ± 1%; 1/4 W; carbon film
R105	6-11049C20	1.82k ± 1%, 1/4 W; carbon film
R106	6-11049D41	32.4k ± 1%, 1/4 W, carbon film
R107	6-11049D88	100k ± 1%, 1/4 W; carbon film
R108	6-11049D91	107k ± 1%, 1/4 W, carbon film
R109	6-11049B77	665 ± 1%; 1/4 W; carbon film
R110	6-11024A41	470
R111 thru 114	6-11024A65	4.7k
R115	6-11024A63	3.9k
R116	6-11024A59	2.7k
R117	6-11024A49	1k
R118	6-11024A65	4.7k
R119	6-11024A49	1k
R120	6-11024A97	100k
R121	6-11024A89	47k
R122	18-80093D02	variable; 10k
R123	6-11024A67	5.6k
R124	6-11024A81	22k
R125	6-11024A19	56
R126	6-124B69	1-1/4 W
R127	6-11024A29	150
R128	6-11041A03	2.7; carbon film
R129, 130	6-11024A65	4.7k
R131, 132	6-11024A25	100
R201, 202	6-11024A25	100
R203, 204	6-11024A49	1k
R205	6-11024A57	2.2k
R206	6-11024A49	1k
R207	6-11024A53	1.5k
R208	6-11024A01	10
R209, 210	6-11024A33	220
R211	6-11024A09	22
R212	6-11024A48	51
R213	6-11024A79	18k
R214, 215	6-11009A29	150; 1/4 W; carbon film
R526	6-11024A65	4.7k

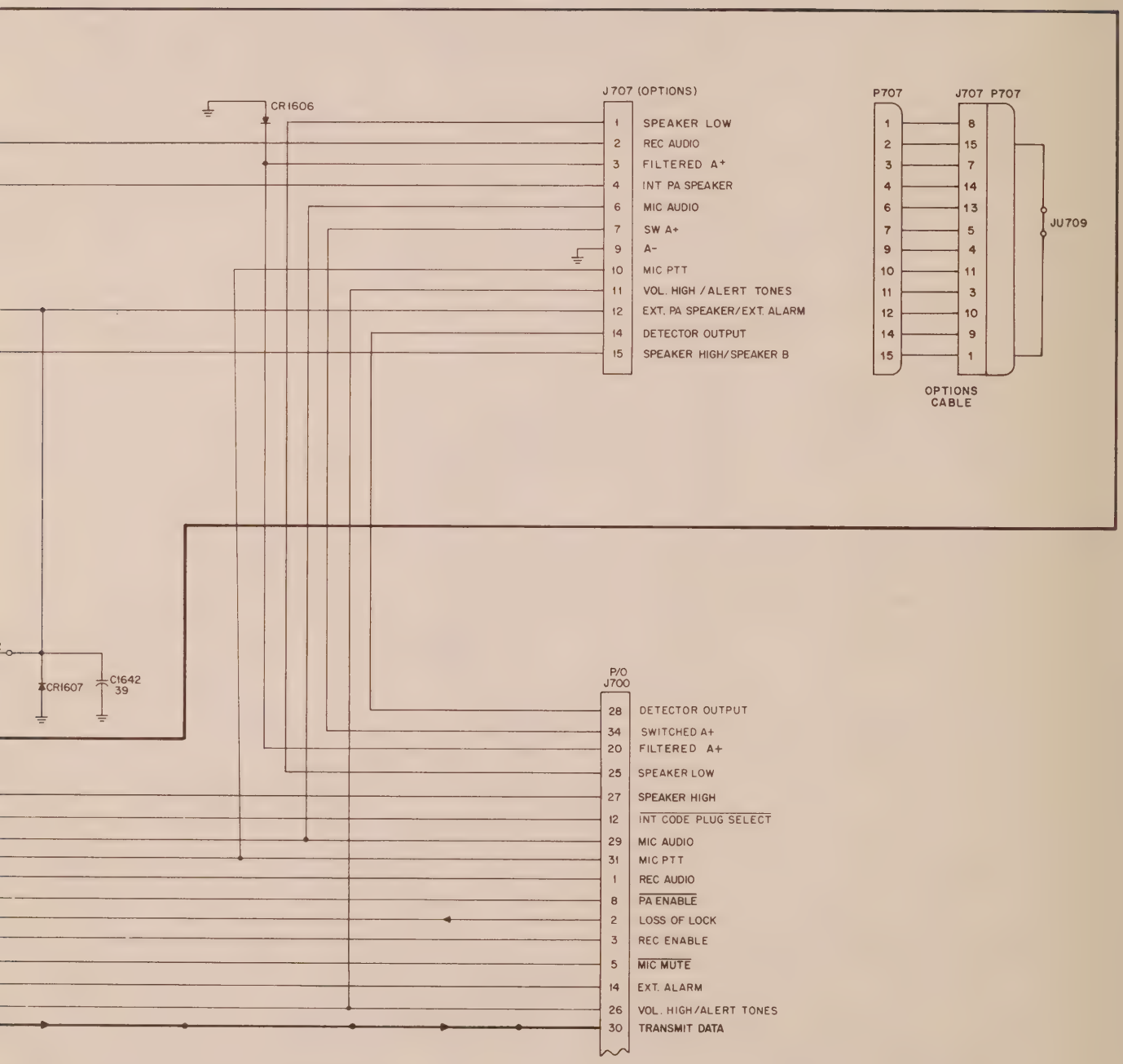
MAIN BOARD

SCHEMATIC DIAGRAM, CIRCUIT BOARD DETAILS, AND PARTS LIST
MODEL HLF4063B

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
R527	6-11024A43	560
R528	6-11024A61	3.3k
R529	6-11024A89	47k
R530	6-11024A43	560
R531	6-11024B02	150k
R532	6-11024A97	100k
R533	6-11024A71	8.2k
R534	6-11024A73	10k
R535	6-11024B16	560
R536	6-11024A53	1.5k
R537, 538	6-11024A65	4.7k
R539, 540, 541	6-11024A80	20k
R542	6-11024A51	1.2k
R543	6-11024A77	15k
R544	6-11024A71	8.2k
R615	17-80290D01	ww 120 ± 10%, 2 W
R665	6-11024A79	18k
R666	6-11024A51	1.2k
R667	6-11024A49	1k
R668	6-11024A71	8.2k
R669	18-80087E01	variable, 25k
R670	6-11024A33	220
R671	6-11024A43	560
R672	6-11024A25	100
R673, 674	6-11024A37	330
R675	6-11024A25	100
R676	6-11024A51	1.2k
R677	6-11024A35	270
R678	6-11024A57	2.2k
R679	6-11024B06	220k
R680	6-11024A71	8.2k
R681	6-11024A31	180
R1100, 1101	18-80087E01	variable, 25 V
R1102	6-11024A45	680
R1103	6-11024A69	6.8k
R1104	6-11024A73	10k
R1105	6-11024A25	100
R1501	6-11024A73	10k
R1502	6-10621C18	1.74k ± 1%; FMF
R1503	6-10621C28	2.21k ± 1%; FMF
R1504	6-11024A45	680
R1505	6-11024A51	1.2k
R1506	6-11024A45	680
R1507, 1508	6-11029A49	150, 1/4 W
R1509, 1510	6-11024A47	820
		integrated circuit: (see note)
U100	51-80066C02	I-F Amplifier
U101	51-80069C05	I-F/Audio Special
U102	51-80065C09	Audio Amplifier
U525	51-80067C06	Quad Op Amplifier
U526	51-80073C05	Trans Gate
U1101	51-80291B01	Oscillator
U1501	51-80067C09	Op Amplifier
U1502	51-80068C02	Voltage Regulator 5 V
		voltage regulator:
VR600	48-80007E01	Zener type, 5.1 V
VR663	48-80007E03	Zener type, 8.8 V
VR1501	48-83461E40	Zener type, 5.2 V
		crystal: (see note)
Y100	91-80011E04	10.7 MHz
Y101	91-80011E05	10.7 MHz
Y102, 103, 104	91-80011E05	10.7 MHz
		mechanical parts
	3-10943M11	SCREW, tapping TT3 × 0.5 × 10: 9 used
	3-80136F01	SCREW, metric HI/LO; 5 used
	5-80000F01	GROMMET, 5 used
	15-80038E01	COVER, mixer
	15-80039E01	COVER, filter, bottom
	15-80040E01	COVER, buffer doubler
	26-80142E01	SHIELD, 10.7 MHz I-F bottom
	26-80143E01	SHIELD, quad
	26-80145E01	SHIELD, local oscillator
	32-80172F01	GASKET, rf deck cover
	32-80171F01	GASKET, rf deck
	26-80049F01	SHIELD, can; 3 used
	26-80049F02	SHIELD, can
	26-80144E01	SHIELD, I-F
	26-80237E01	SHIELD, xtal
	43-80218E01	SPACER, mounting Q663, 1501, U102, 1502
	2-80080D01	NUT, tension, 9 used
	3-80079D01	SCREW, set filter, 9 used
	15-80034E02	COVER, 2-cell
	15-80035E02	COVER, 3-cell
	15-80036E02	COVER, 4-cell
	15-80033E01	HOUSING, 800 mH filter

note: For optimum performance, diodes, transistors, and integrated circuits must be ordered by Motorola part numbers.

MAIN BOARD



ND

THEORY NOTE

MAINTENANCE NOTE

CONTROL SIGNAL FLOW

RECEIVE DATA

TRANSMIT DATA

EEPS-38572-O
(SHEET 1 OF 2)

(A) *U1604 acts as a 2 pole, four position switch.*

(B) *Low speed attenuator reduces transmit data voltage to 1 kHz deviation level.*

(C) *U1608C is closed during HI SPEED to reduce RC time constant of R1651, R1652, C1626 and C1627.*

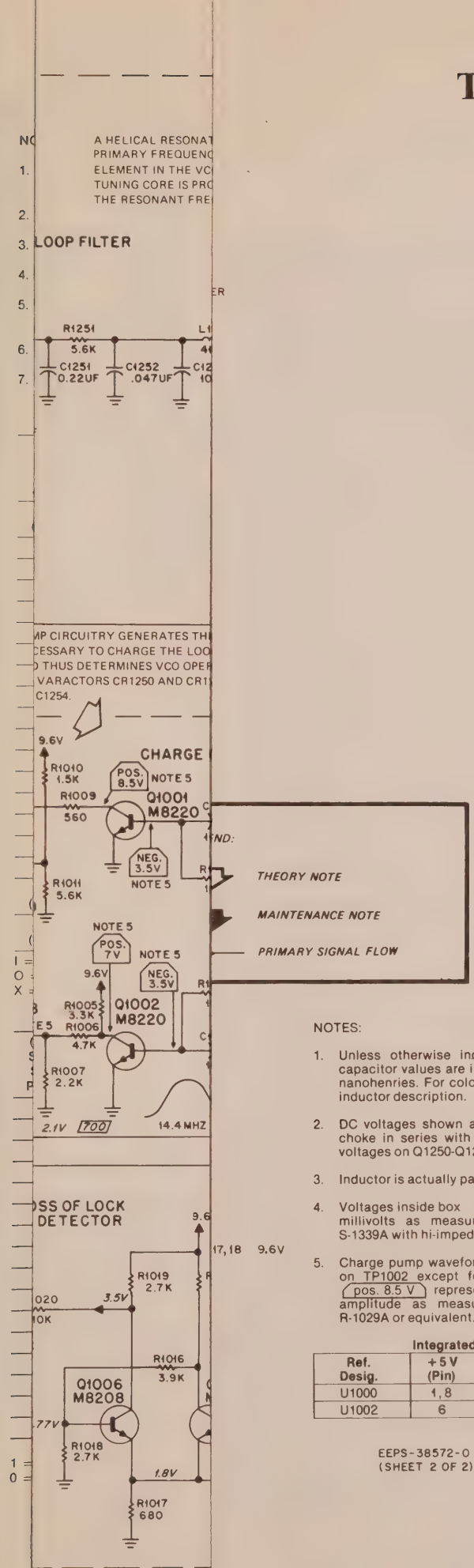
(D) *Microcomputer monitors PA ENABLE and resets if any erroneous transmissions occur while in receive mode.*

(E) *Q1608 enables the code plug (pin 13 enable), turns on the code plug power via Q1609, and disables the synthesizer strobe via CR1605.*

(F) *"Tickle" is an activity indicator used by the watchdog timer. If "tickle" is not present at Q1603, the microcomputer will be reset when the voltage at U1603 pin 6 rises above the reference on pin 7.*

TRUNKED COMMAND BOARD

SCHEMATIC DIAGRAM, CIRCUIT BOARD DETAILS, AND PARTS LIST MODEL HLF4080A



NOTES:

1. Unless otherwise indicated, resistor values are in ohms, capacitor values are in picofarads, and inductor values are in nanohenries. For color coded inductors, refer to parts list for inductor description.
2. DC voltages shown are referenced to A−. Use a 410 nH rf choke in series with positive test lead when measuring dc voltages on Q1250-Q1253.
3. Inductor is actually part of circuit board foil.
4. Voltages inside box /240/ represent RMS RF voltages in millivolts as measured with RF millivoltmeter, Motorola S-1339A with hi-impedance probe or equivalent.
5. Charge pump waveforms are all basically the same as found on TP1002 except for amplitude. Information inside box, /pos. 8.5 V/ represent waveform polarity and peak to peak amplitude as measured with an oscilloscope, Motorola R-1029A or equivalent.

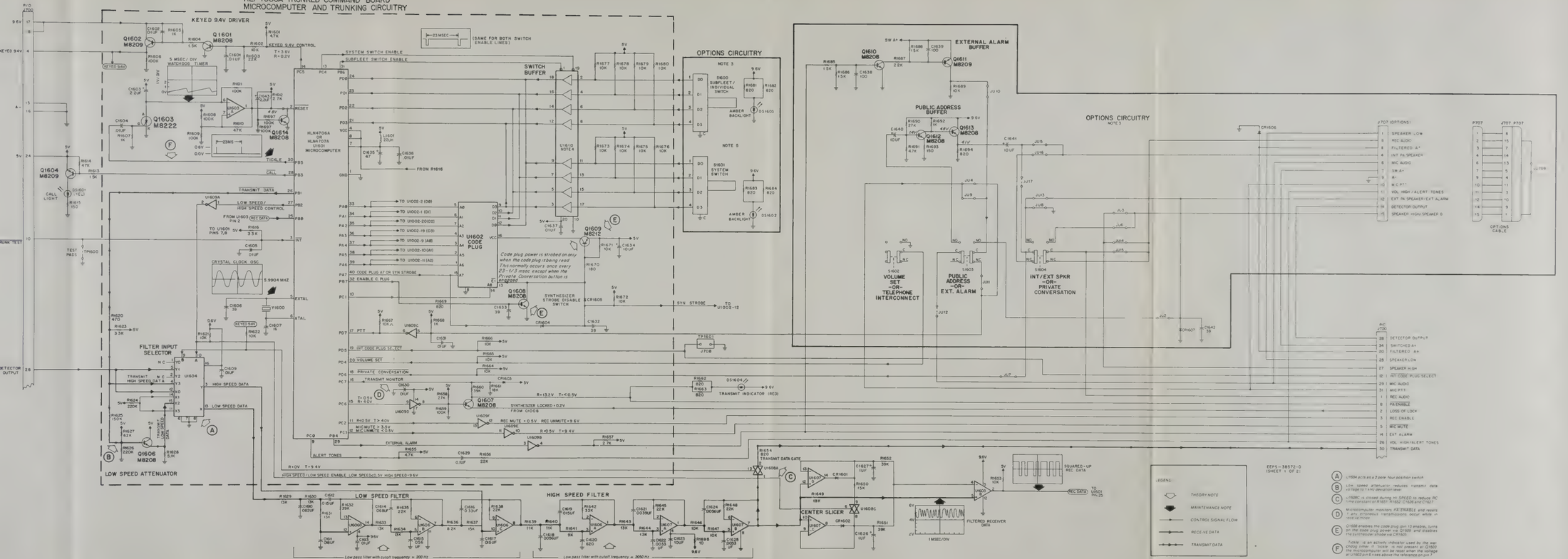
Integrated Circuit Reference Table

Ref. Desig.	+5 V (Pin)	Gnd (Pin)	Description
U1000	1, 8	4	÷127/128 prescaler
U1002	6	4	frequency synthesizer

EEPS-38572-O
(SHEET 2 OF 2)

TRUNKED COMMAND BOARD

SCHEMATIC DIAGRAM, CIRCUIT BOARD DETAILS, AND PARTS LIST
MODEL HLF4080A



68P81066E42-O
(Sheet 1 of 3)
2/10/84-PHI

NOTES:

1. Unless otherwise indicated, resistor values are in ohms, capacitor values are in picofarads, and inductor values are in microhenries.
2. DC voltages shown are referenced to A--.
3. Boxed circuitry is optional.
4. U1610 used only with system and subfleet switch options.
5. See switch binary code table for S1600 and S1601 switch position data output information.
6. JU1 and JU601 are on main board. See Main Board schematic diagram.
7. J3709 is located in P709 Option Connector.

Option Jumper Usage Table

Jumper	Standard "No-Option" Radio	B18 Ext Rec Audio Splr	B109 Handset w/H.U.C.	B116 External Alarm	B330 Public Address	B488A/3 Rec Audio	B589 Public Address with Int/Ext PA Switch	B700 Public Address with A/B Rec Switch	B704/B705 Simple/Multi Private Conversation	B113 Ignition Switch Cable
JU1 (Note 6)	O	O	O	O	O	O	O	O	O	O
JU2	X	X	X	I	O	X	O	O	X	X
JU3	I	X	I	I	I	O	I	O	I	X
JU4	I	X	X	I	O	I	O	O	I	X
JU5	X	X	X	X	I	X	O	I	X	X
JU6	X	X	X	X	X	I	O	I	O	X
JU7	O	O	O	O	O	O	O	O	I	X
JU8	X	X	X	X	X	X	O	O	I	X
JU9	X	X	X	O	I	X	I	I	X	X
JU10	O	O	O	I	O	O	O	O	O	X
JU11	X	X	X	O	I	X	I	I	X	X
JU12	X	X	X	O	I	X	I	I	X	X
JU13	X	X	X	O	X	X	I	O	O	X
JU14	O	O	O	O	O	I	O	I	O	X
JU15	I	I	I	I	I	O	I	O	I	X
JU16	X	X	X	X	X	X	I	X	O	X
JU17	X	X	X	X	O	X	I	X	O	X
JU601 (Note 6)	X	X	X	X	X	X	X	X	X	O
JU709 (Note 7)	I	O	X	X	O	X	O	X	O	X

I = IN REQUIRED FOR THIS OPTION
O = OUT, REQUIRED FOR THIS OPTION
X = IN, UNLESS RADIO CONTAINS ANOTHER OPTION REQUIRING JUMPER TO BE OUT

Switch Binary Code Table

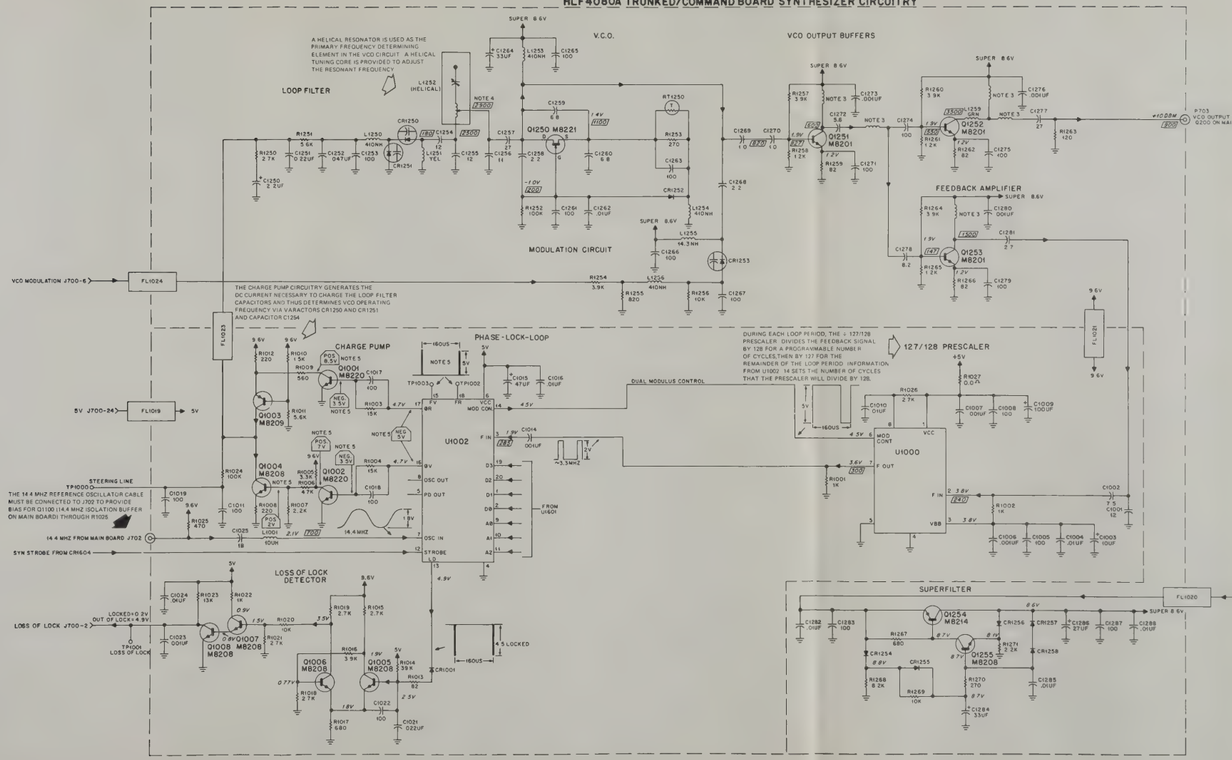
(S1601) System Switch Position	Pin Numbers 4 (D3)	3 (D2)	2 (D1)	1 (D0)	(S1600) Subfleet/ Individual Switch Positions
1	1	1	1	1	A
2	1	1	1	0	B
3	1	1	0	1	C
4	1	1	0	0	D
5	1	0	1	1	E
6	1	0	1	0	F
	1	0	0	1	G
	1	0	0	0	H
	0	1	1	1	7
	0	1	1	0	6
	0	1	0	0	5
	0	0	1	1	4
	0	0	1	0	3
	0	0	0	1	2
	0	0	0	0	1

1 = Logic High
0 = Logic Low

Integrated Circuit Reference Table

Ref Desig.	+5 V (Pin)	+9.6 V (Pin)	Gnd (Pin)	Description
U1601	4, 7, 8		1	Microcomputer
U1602	16 (strobed)		8	Code Plug PROM
U1603		3	12	Quad Comp.
U1604		16	8	Filter Input Selector
U1606		4	11	Quad Op Amp
U1607		4	11	Quad Op Amp
U1608		14	7	T-Gate
U1609	14		7	Inverter
U1610	20		10	Octal Buffer

HLF4080A TRUNKED/COMMAND BOARD SYNTHESIZER CIRCUITRY



NOTES

1. Unless otherwise indicated, resistor values are in ohms, capacitor values are in picofarads, and inductor values are in nanohenries. For color coded inductors, refer to parts list for inductor description.
2. DC voltages shown are referenced to A--. Use a 410 nH rf choke in series with positive test lead when measuring dc voltages on Q1250-Q1253.
3. Inductor is actually part of circuit board foil.
4. Voltages inside box [2.9V] represent RMS RF voltages in millivolts as measured with RF millivoltmeter, Motorola S-1339A with h-impedance probe or equivalent.
5. Charge pump waveforms are all basically the same as found on TP1002 except for amplitude. Information inside box [20% 8.5 V] represent waveform polarity and peak to peak amplitude as measured with an oscilloscope. Motorola R1029A or equivalent.

Integrated Circuit Reference Table

Ref Desig.	+5 V (Pin)	Gnd (Pin)	Description
U1000	1, 8	4	÷ 127/128 prescaler
U1002	6	4	Frequency synthesizer

EEPS-38572-O
(SHEET 2 OF 2)

TRUNKED COMMAND BOARD

SCHEMATIC DIAGRAM, CIRCUIT BOARD DETAILS, AND PARTS LIST
MODEL HLF4080A

TRUNK COMMAND BOARD

68P81066E42-O
(Sheet 2 of 3)
2/10/84-PHI

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		coil, rf:
L1001	24-80044F01	choke; 10 uH
L1250	24-80002E03	choke; 0.41 uH
L1251	24-11030D03	32.0 nH (coded YEL)
L1252	1-80710T66	HELICAL, assembly
L1253-1256	24-80002E03	choke; 0.41 uH
L1259	24-11030D04	46.9 nH (coded GRN)
L1601	24-80044F02	choke; 22 uH
		connector, plug:
P703	30-80031E01	cable includes; plug
		transistor: (see note)
Q1001, 1002	48-80182D20	NPN; type M8220
Q1003	48-80182D09	PNP; type M8209
Q1004-1008	48-80182D08	NPN; type M8208
Q1250	48-80182D17	field-effect
Q1251-1253	48-80182D01	NPN; type M8201
Q1254	48-80182D14	PNP; type M8214
Q1255	48-80182D08	NPN; type M8208
Q1601	48-80182D08	NPN; type M8208
Q1602	48-80182D09	PNP; type M8209
Q1603	48-80182D22	Controlled Rectifier M8222
Q1604	48-80182D09	PNP; type M8209
Q1606-1608	48-80182D08	NPN; type M8208
Q1609	48-81082D12	PNP; type M8212
Q1610	48-81082D08	NPN; type M8208
Q1611	48-80182D09	PNP; type M8209
Q1612, 1613, 1614	48-80182D08	NPN; type M8208
		resistor, fixed: (chip) ± 5%; 1/8 W: unless otherwise stated
R1001	6-11024A19	1k
R1003, 1004	6-11024A77	15k
R1005	6-11024A61	3.3k
R1006	6-11024A65	4.7k
R1007	6-11024A57	2.2k
R1008	6-11024A33	220
R1009	6-11024A43	560
R1010	6-11024A53	1.5k
R1011	6-11024A67	5.6k
R1012	6-11024A33	220
R1013	6-11024A23	82
R1014	6-11024A87	39k
R1015	6-11024A59	2.7k
R1016	6-11024A63	3.9k
R1017	6-11024A45	680
R1018, 1019	6-11024A59	2.7k
R1020	6-11024A73	10k
R1021	6-11024A59	2.7k
R1022	6-11024A49	1k
R1023	6-11024A76	13k
R1024	6-11024A97	100k
R1025	6-11024A41	470
R1026	6-11024A59	2.7k
R1027	6-11024B23	0 (jumper)
R1250	6-11024A59	2.7k
R1251	6-11024A67	5.6k
R1252	6-11024A97	100k
R1253	6-11024A35	270
R1254	6-11024A63	3.9k
R1255	6-11024A47	820
R1256	6-11024A73	10k
R1257	6-11024A63	3.9k
R1258	6-11024A51	1.2k
R1259	6-11024A23	82
R1260	6-11024A63	3.9k
R1261	6-11024A51	1.2k
R1262	6-11024A23	82
R1263	6-11024A27	120
R1264	6-11024A63	3.9k
R1265	6-11024A51	1.2k
R1266	6-11024A23	82
R1267	6-11024A45	680
R1268	6-11024A71	8.2k
R1269	6-11024A23	10k
R1270	6-11024A35	270
R1271	6-11024A57	2.2k
R1601	6-11024A65	4.7k
R1602	6-11024A73	10k
R1603	6-11024A81	22k
R1604	6-11024A53	1.5k
R1605	6-11024A49	1k
R1606	6-11024A97	100k
R1607	6-11024A49	1k
R1608, 1609	6-11024A97	100k
R1610	6-11024A89	47k
R1611	6-11024A97	100k
R1612	6-11024A59	2.7k
R1613	6-11024A53	1.5k
R1614	6-11024A65	4.7k
R1615	6-11024A29	150
R1616	6-11024A61	3.3k

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
R1620	6-11024A41	470
R1621, 1622	6-11024A73	10k
R1623	6-11024A61	3.3k
R1624	6-11024B06	220k
R1625	6-11024B02	150k
R1626	6-11024B06	220k
R1627	6-11024A92	62k
R1628	6-11024A66	5.1k
R1629, 1630, 1631	6-11024A76	13k
R1632	6-11024A87	39k
R1633, 1634	6-11024A76	13k
R1635	6-11024A81	22k
R1636	6-11024A71	8.2k
R1637	6-11024A77	15k
R1638	6-11024A81	22k
R1639, 1640, 1641	6-11024A74	11k
R1642	6-11024A85	33k
R1643, 1644	6-11024A76	13k
R1645	6-11024A81	22k
R1646, 1647	6-11024A73	10k
R1648	6-11024A81	22k
R1649	6-11024A79	18k
R1650	6-11024A77	15k
R1651, 1652	6-11024A87	39k
R1653	6-11024A73	10k
R1654	6-11024A47	820
R1655	6-11024A65	4.7k
R1656	6-11024A81	22k
R1657, 1658	6-11024A59	2.7k
R1659	6-11024A97	100k
R1660	6-11024A87	39k
R1661	6-11024A79	18k
R1662, 1663	6-11024A47	820
R1664-1667	6-11024A73	10k
R1668	6-11024A49	1k
R1669	6-11024A47	820
R1670	6-11024A31	180
R1671-1680	6-11024A73	10k
R1681-1684	6-11024A47	820
R1685, 1686	6-11024A53	1.5k
R1687	6-11024A57	2.2k
R1688	6-11024A53	1.5k
R1689	6-11024A73	10k
R1690	6-11024A83	27k
R1691	6-11024A65	4.7k
R1692	6-11024A49	1k
R1693	6-11024A29	150
R1694	6-11024A47	820
R1695	6-11024A01	10
R1696, 1697	6-11024A97	100k
		thermistor:
RT1250	6-80284D01	3k @ 25°C
		integrated circuit: (see note)
U1000	51-83977M45	÷ 127/128 prescaler
U1002	51-80071C08	frequency synthesizer (PLL)
U1603	51-80067C08	quad comparator
U1604	51-80073C06	analog mux
U1606, 1607	51-80067C07	quad op-amplifier
U1608	51-80073C05	t-gate
U1609	51-80135C03	inverter
U1610	51-80071C10	octal buffer
		crystal: (see note)
Y1600	48-80173D02	5.9904 MHz

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		mechanical parts
	9-80276E01	SOCKET, ic; 16-contact
	9-80276E04	SOCKET, ic; 40-contact
	3-10943M11	SCREW, tapping; TT3 × 0.6 × 8; 17 used
	15-80028E01	COVER, synthesizer top
	15-80029E01	COVER, synthesizer bottom
	32-80173F01	GASKET, synthesizer
	2-80060D01	NUT, jam; 10-32
	3-80059D01	SCREW, set
	15-80016F01	HOUSING, coil
	15-80027E01	HOUSING, synthesizer

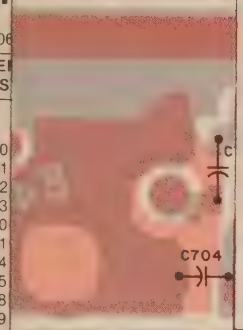
HLN4706A Microprocessor or
HLN4707A Microprocessor PL-8887-O

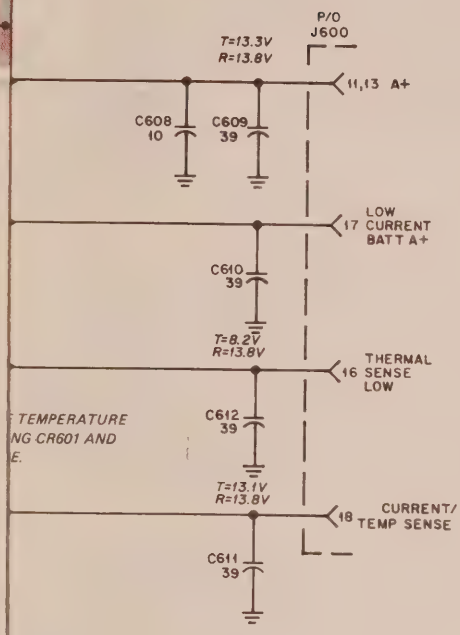
REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
U1601	51-97015C02	microcomputer (HLN4706)
	51-97015C03	microcomputer (HLN4707)

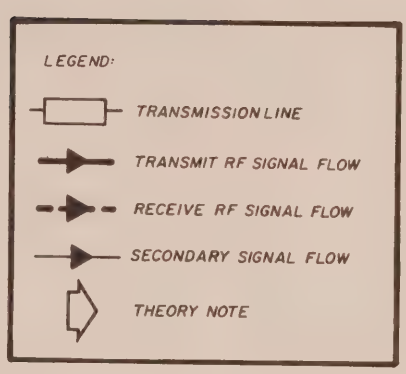
note: The difference between HLN4706A and HLN4707A is the internal programming.

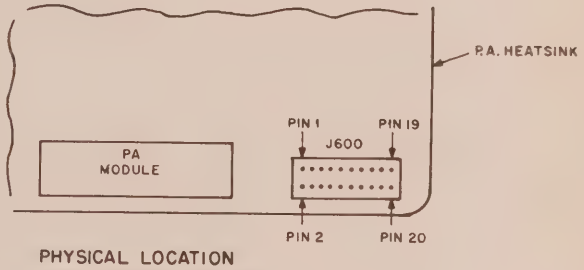
POWER AMPLIFIER BOARD

SCHEMATIC DIAGRAM, CIRCUIT BOARD DETAILS, AND PARTS LIST MODEL HLF4064A

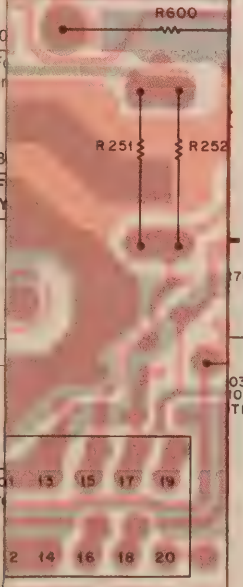






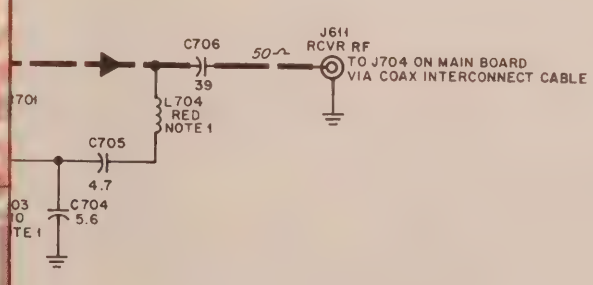


PHYSICAL LOCATION
J600 COMPONENT SIDE VIEW

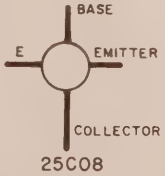


IN THE TRANSMIT STATE, PIN DIODES CR700 & CR701 ARE BIASED ON, PROVIDING A LOW LOSS PATH BETWEEN THE TRANSMITTER AND THE ANTENNA WHILE ISOLATING THE RECEIVER PORT FROM THE TRANSMITTER.

IN THE RECEIVE STATE, PIN DIODES CR700 & CR701 ARE OFF PROVIDING A LOW LOSS PATH BETWEEN RECEIVER AND THE ANTENNA WHILE ISOLATING THE TRANSMITTER FROM THE ANTENNA.



Q250 DETAIL



25C08

NOTES:

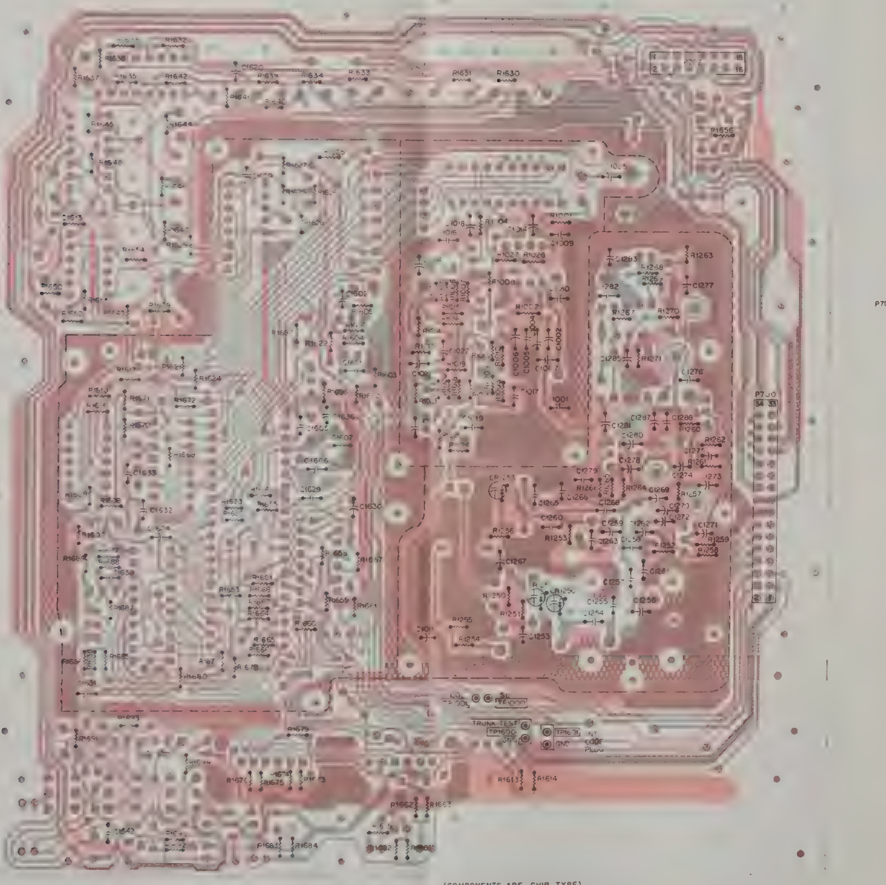
1. Unless otherwise indicated: resistor values are in ohms; capacitor values are in picofarads. Refer to parts list for inductor description.
2. DC voltages shown are referenced to A-.
3. This inductor is actually part of the circuit board foil.

POWER AMPLIFIER BOARD

68P81063E44-A
2/10/84-PHI

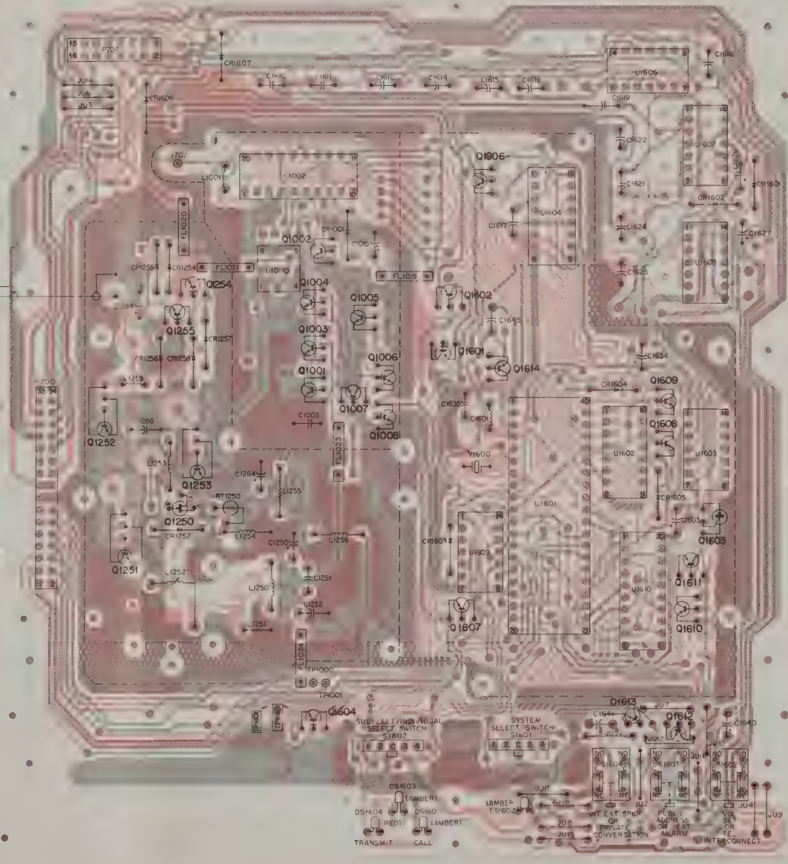
TRUNKED COMMAND BOARD

SCHEMATIC DIAGRAM, CIRCUIT BOARD DETAILS, AND PARTS LIST
HLF4080A



(COMPONENTS ARE CHIP TYPE)

SOLDER SIDE VIEW
• COMPONENT SIDE - EEPS-38645-O (REVERSED)
• SOLDER SIDE - EEPS-38646-O (REVERSED)
OL - EEPS-38647-O



COMPONENT SIDE VIEW
• COMPONENT SIDE EEPS-38645-O
• SOLDER SIDE EEPS-38646-O
OL - EEPS-38648-O

68P81066E42-O
(Sheet 3 of 3)
2-10-84-PHI

parts list

HLF4080A Trunked Command Board — PL-8886-O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		capacitor, fixed: uF ± 5%; 50 V: unless otherwise stated
C1001	21-11031A17	12 pF (chip)
C1002	21-11031A12	7.5 pF ± 0.5 pF (chip)
C1003	23-11019A20	10 ± 20%; 25 V
C1004	21-11032B07	.01 + 80 – 20%; (chip)
C1005	21-11031A39	100 pF (chip)
C1006, 1007	21-11032B01	.001 + 80 – 20% (chip)
C1008	21-11031A39	100 pF (chip)
C1009	23-11019A46	100 ± 20%, 25 V
C1010	21-11032B07	.01 + 80 – 20% (chip)
C1011	21-11031A39	100 pF (chip)
C1014	21-11032B01	.001 + 80 – 20 (chip)
C1015	23-11019A40	47 ± 20%; 25 V
C1016	21-11032B07	.01 + 80 – 20% (chip)
C1017-1019	21-11031A39	100 pF (chip)
C1021	21-11031B09	.022 + 80 – 20% (chip)
C1022	21-11031A39	100 pF (chip)
C1023	21-11032B01	.001 + 80 – 20% (chip)
C1024	21-11032B07	.01 + 80 – 20% (chip)
C1025	21-11031A21	18 pF (chip)
C1250	23-11013D05	2.2 ± 10%, 20 V
C1251	8-11051A15	0.22
C1252	21-11017A14	.047
C1253	21-11031A39	100 pF (chip)
C1254	21-11031A17	12 pF ± 0.5% (chip)
C1255	21-11031A17	12 pF (chip)
C1256	21-11031A16	11 pF ± 0.5 pF (chip)
C1257	21-11031A25	27 pF (chip)
C1258	21-11031A05	2.2 pF ± 0.25 pF (chip)
C1259, 1260	21-11031A11	6.8 ± 0.5 pF (chip)
C1261	21-11031A39	100 ± 5% (chip)
C1262	21-11032B07	.01 + 80 – 20% (chip)
C1263	21-11031A39	100 pF (chip)
C1264	23-11031A33	33 ± 2%, 25 V
C1265, 1266, 1267	21-11031A39	100 pF (chip)
C1268	21-11031A05	2.2 pF ± 0.25 pF (chip)
C1269, 1270	21-11031A01	1.0 pF ± 0.25 pF (chip)
C1271	21-11031A39	100 pF (chip)
C1272	21-11031A10	5.6 pF ± 0.5 pF (chip)
C1273	21-11032B01	.001 + 80 – 20% (chip)
C1274, 1275	21-11031A39	100 pF (chip)
C1276	21-11032B01	.001 + 80 – 20% (chip)
C1277	21-11031A25	27 pF (chip)
C1278	21-11031A13	8.2 ± 0.5 pF (chip)
C1279	21-11031A39	100 pF (chip)
C1280	21-11032B01	.001 + 80 – 20% (chip)
C1281	21-11031A06	2.7 pF ± 0.5 pF (chip)
C1282	21-11032B07	.01 + 80 – 20% (chip)
C1283	21-11031A39	100 pF (chip)
C1284	23-11019A33	33 ± 20%, 25 V
C1285	21-11032B07	.01 + 80 – 20% (chip)
C1286	23-11013C12	27 ± 10%; 15 V
C1287	21-11031A39	100 pF (chip)
C1288	21-11032B07	.01 + 80 – 20% (chip)
C1601, 1602	21-11032B07	.01 + 80 – 20% (chip)
C1603	23-11019A11	2.2 ± 20%
C1604, 1605	21-11032B07	.01 + 80 – 20% (chip)
C1606	21-11031A29	39 pF (chip)
C1607	21-11031A20	16 pF (chip)
C1609	21-11032B07	.01 + 80 – 20% (chip)
C1610	8-11017A31	.082
C1611	8-11017A10	.018
C1612	8-11051A14	0.15
C1613	21-11032B07	.01 + 80 – 20% (chip)
C1614	8-11017A16	.068
C1615	8-11017A15	.056
C1616	8-11051A16	0.33
C1617	8-11017A09	.015
C1618	8-11017A19	.0056
C1619	8-11017A09	.015
C1620	21-11031A58	620 pF (chip)
C1621	8-11017B23	.0039 ± 10%
C1622	8-11017A05	.0033
C1623	23-11019A20	10 ± 20%; 25 V
C1624	8-11017A19	.0056
C1625	8-11017A05	.0033
C1626, 1627	23-11019A09	1 ± 20%
C1629	21-11032B13	0.10 + 80 – 20% (chip)
C1630, 1631	21-11032B07	.01 + 80 – 20% (chip)
C1632	21-11031A29	39 pF (chip)
C1633	21-11031A29	39 pF (chip)
C1634	23-11019A20	10 ± 20%
C1635	23-11019A40	47 ± 20%
C1636	21-11032B07	.01 + 80 – 20% (chip)
C1637	21-11032B07	.01 + 80 – 20% (chip)
C1638, 1639	21-11031A39	100 pF (chip)
C1640, 1641	23-11019A20	10 ± 20%
C1642	21-11031A29	39 (chip)
C1643	23-11019A11	2.2 ± 20%
		diode: (see note)
CR1001	48-80005E01	silicon
CR1250, 1251	48-80006E04	varactor
CR1252	48-80012E01	hot carrier
CR1253	48-80006E04	varactor
CR1254 thru 1258	48-80005E01	silicon
CR1601, 1602	48-80012E01	hot carrier
CR1603 thru 1605	48-80005E01	silicon
CR1606	48-80008E01	silicon
CR1607	48-80005E01	silicon
		light emitting diode: (see note)
DS1601	48-80159E06	yellow
DS1604	48-80159E05	red
		filter
FL1019 thru 1024	01-80045F02	Assembly feed-thru plate
		connector, receptacle:
J700	28-80085E01	male; 34 contact
J702		consists of:
	15-80174F01	HOUSING, rf connector
	15-80175F01	COVER, rf connector
	39-80065F01	CONTACT, rf connector
J707	28-80085E06	male; 15 contact
J708	28-80085E05	male; 2 contact
		jumper, resistor:
JU2 thru 17	6-11009B23	1 ± 5%; 1/4 W
		coil, rf:
L1001	24-80044F01	choke, 10 uH
L1250	24-80002E03	choke, 0.41 uH
L1251	24-11030D03	32.0 nH (coded YEL)
L1252	1-80710T66	HELICAL, assembly
L1253-1256	24-80002E03	choke, 0.41 uH
L1259	24-11030D04	46.9 nH (coded GRN)
L1601	24-80044F02	choke, 22 uH
		connector, plug:
P703	30-80031E01	cable includes, plug
		transistor: (see note)
Q1001, 1002	48-80182D20	NPN, type M8220
Q1003	48-80182D09	PNP, type M8209
Q1004-1008	48-80182D08	NPN, type M8208
Q1250	48-80182D17	field-effect
Q1251, 1253	48-80182D01	NPN, type M8201
Q1254	48-80182D14	PNP, type M8214
Q1255	48-80182D08	NPN, type M8208
Q1601	48-80182D08	NPN, type M8208
Q1602	48-80182D09	PNP, type M8209
Q1603	48-80182D22	Controlled Rectifier M8222
Q1604	48-80182D09	PNP, type M8209
Q1606-1608	48-80182D08	NPN, type M8208
Q1609	48-81082D12	PNP, type M8212
Q1610	48-81082D08	NPN, type M8208
Q1611	48-80182D09	PNP, type M8209
Q1612, 1613, 1614	48-80182D08	NPN, type M8208
		resistor, fixed: (chip) ± 5%; 1/8 W: unless otherwise stated
R1001	6-11024A19	1k
R1003, 1004	6-11024A77	15k
R1005	6-11024A61	3.3k
R1006	6-11024A65	4.7k
R1007	6-11024A57	2.2k
R1008	6-11024A33	220
R1009	6-11024A43	560
R1010	6-11024A53	1.5k
R1011	6-11024A67	5.6k
R1012	6-11024A33	220
R1013	6-11024A23	82
R1014	6-11024A87	39k
R1015	6-11024A59	2.7k
R1016	6-11024A63	3.9k
R1017	6-11024A45	680
R1018, 1019	6-11024A59	2.7k
R1020	6-11024A73	10k
R1021	6-11024A59	2.7k
R1022	6-11024A49	1k
R1023	6-11024A76	13k
R1024	6-11024A97	100k
R1025	6-11024A41	470
R1026	6-11024A59	2.7k
R1027	6-11024B23	0 (jumper)
R1250	6-11024A59	2.7k
R1251	6-11024A67	5.6k
R1252	6-11024A97	100k
R1253	6-11024A35	270
R1254	6-11024A63	3.9k
R1255	6-11024A47	820
R1256	6-11024A73	10k
R1257	6-11024A63	3.9k
R1258	6-11024A51	1.2k
R1259	6-11024A23	82
R1260	6-11024A63	3.9k
R1261	6-11024A51	1.2k
R1262	6-11024A23	82
R1263	6-11024A27	120
R1264	6-11024A63	3.9k
R1265	6-11024A51	1.2k
R1266	6-11024A23	82
R1267	6-11024A45	680
R1268	6-11024A71	8.2k
R1269	6-11024A23	10k
R1270	6-11024A35	270
R1271	6-11024A57	2.2k
R1601	6-11024A65	4.7k
R1602	6-11024A73	10k
R1603	6-11024A81	22k
R1604	6-11024A53	1.5k
R1605	6-11024A49	1k
R1606	6-11024A97	100k
R1607	6-11024A49	1k
R1608, 1609	6-11024A97	100k
R1610	6-11024A89	47k
R1611	6-11024A97	100k
R1612	6-11024A59	2.7k
R1613	6-11024A53	1.5k
R1614	6-11024A65	4.7k
R1615	6-11024A29	150
R1616	6-11024A61	3.3k
R1620	6-11024A41	470
R1621, 1622	6-11024A73	10k
R1623	6-11024A61	3.3k
R1624	6-11024B06	220k
R1625	6-11024B02	150k
R1626	6-11024B06	220k
R1627	6-11024A92	62k
R1628	6-11024A66	5.1k
R1629, 1630, 1631	6-11024A76	13k
R1632	6-11024A87	39k
R1633, 1634	6-11024A76	13k
R1635	6-11024A81	22k
R1636	6-11024A71	8.2k
R1637	6-11024A77	15k
R1638	6-11024A81	22k
R1639, 1640, 1641	6-11024A74	11k
R1642	6-11024A85	33k
R1643, 1644	6-11024A76	13k
R1645	6-11024A81	22k
R1646, 1647	6-11024A73	10k
R1648	6-11024A81	22k
R1649	6-11024A79	18k
R1650	6-11024A77	15k
R1651, 1652	6-11024A87	39k
R1653	6-11024A73	10k
R1654	6-11024A47	820
R1655	6-11024A65	4.7k
R1656	6-11024A81	22k
R1657, 1658	6-11024A59	2.7k
R1659	6-11024A97	100k
R1660	6-11024A87	39k
R1661	6-11024A79	18k
R1662, 1663	6-11024A47	820
R1664, 1667	6-11024A73	10k
R1668	6-11024A49	1k
R1669	6-11024A47	820
R1670	6-11024A31	180
R1671, 1680	6-11024A73	10k
R1681, 1684	6-11024A47	820
R1685, 1686	6-11024A53	1.5k
R1687	6-11024A57	2.2k
R1688	6-11024A53	1.5k
R1689	6-11024A73	10k
R1690	6-11024A83	27k
R1691	6-11024A65	4.7k
R1692	6-11024A49	1k
R1693	6-11024A29	150
R1694	6-11024A47	820
R1695	6-11024A01	10
R1696, 1697	6-11024A97	100k
		thermistor:
RT1250	6-80284D01	3k @ 25 °C
		integrated circuit: (see note)
U1000	51-83977M45	– 127/128 prescaler
U1002	51-80071C08	frequency synthesizer (PLL)
U1603	51-80067C08	quad comparator
U1604	51-80073C06	analog mux
U1606, 1607	51-80067C07	quad op-amplifier
U1608	51-80073C05	t-gate
U1609	51-80135C03	inverter
U1610	51-80071C10	octal buffer
		crystal (see note)
Y1600	48-80173D02	5.9904 MHz

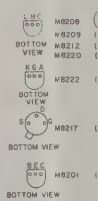
REFERENCE SYMBOL	MOTOROLA PART NO	DESCRIPTION
		mechanical parts
	9-80276E01	SOCKET, ic, 16 contact
	9-80276E04	SOCKET, ic, 40 contact
	3-10943M11	SCREW, tapping, [illegible]
	15-80028E01	COVER, synthesizer, [illegible]
	15-80029E01	COVER, synthesizer bottom
	32-80173F01	GASKET, synthesizer
	2-80060D01	NUT, jam, 10-32
	3-80059D01	SCREW, set
	15-80016F01	HOUSING, coil
	15-80027E01	HOUSING, synthesizer

HLN4706A Microprocessor
HLN4707A Microprocessor — PL-8887

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
U1601	51-97015C02	microcomputer (HLN4706)
	51-97015C03	microcomputer (HLN4707)

note: The difference between HLN4706A and HLN4707A is the internal programming

TRANSISTOR BASE DETAILS



M8208 (Q1004, Q1005, Q1006, Q1007, Q1008, Q1255, Q1601, Q1606, Q1607, Q1608, Q1610, Q1612, Q1613, Q1614)
M8209 (Q1602, Q1604, Q1611, Q1003)
M8212 (Q1609)
M8220 (Q1001, Q1002)
M8222 (Q1603)
M8217 (Q1250)
M8201 (Q1251, Q1252, Q1253)

parts list

HLF4064A Power Amplifier Board — PL-6703-A

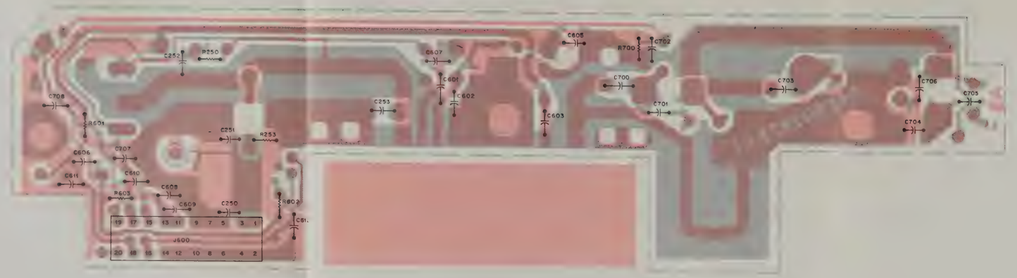
REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		capacitor, fixed: pF ± 5%, 50 V; unless otherwise stated
C250	21-11031A10	5.6 ± 0.25 pF (chip)
C251	21-11031A13	8.2 ± 0.5 pF (chip)
C252	21-11031A29	39 (chip)
C253	21-11031A08	3.9 ± .025 pF (chip)
C600	23-10119A09	1 uF ± 20%
C601 thru 603	21-11032B13	0.1 uF + 80 – 20% (chip)
C604	23-10119A40	100uF ± 20%, 25 V
C605 thru 607	21-11031A29	39 (chip)
C608	21-11031A15	10 ± 0.5 pF (chip)
C609 thru 612	21-11031A29	39 (chip)
C700	21-11033B15	12 ± 0.5 pF, 100 V (chip)
C701 702	21-11031A29	39 (chip)
C703	21-11033B05	4.7 ± 0.5 pF, 100 V (chip)
C704	21-11033B07	5.6 ± 0.5 pF, 100 V (chip)
C705	21-11031A09	4.7 ± 0.25 pF (chip)
C706	21-11031A29	39 (chip)
C707 708	21-11032B13	0.1 uF + 80 – 20% (chip)
		diode (see note)
CR600	48-80009E01	silicon
CR601	48-80005E01	silicon
CR700, 701	48-80010E01	silicon, pin
J601	9-80065D01	connector, receptacle: female, 20 contact (card edge)
J611	9-80061F01	female, single contact (phono)
		coil, rf:
L550	24-11030D06	86.6 nH coded VIO
L700	24-11030D02	21.3 nH coded ORG
L701	24-11030D06	86.6 nH coded VIO
L702	24-11030E06	1/2 turn, coded BLU
L703	24-11030D06	86.6nH coded VIO
L704	24-11030D01	14.1 nH, coded RED
		transistor (see note)
Q250	48-84411L37	NPN, type MT137
		resistor, fixed, ± 5%, 1/8 W, unless otherwise stated
R250	6-11024A25	100 (chip)
R251, 252	6-11008A11	27, 1/4 W
R253	6-11024A18	51 (chip)
R600	17-80290D04	05 ± 10%, 2 W, Wirewound
R601	6-11024A21	68 (chip)
R602	6-11024A61	3.3k (chip)
R603	6-11024A56	2.0k (chip)
R700	6-11024A73	10k (chip)
		thermistor
RT600	6-80286D01	100k Ω @ 25°C

note: For optimum performance, diodes, transistors, and integrated circuits must be ordered by Motorola part numbers.

HLN4366A Power Amplifier Hardware — PL-6294-O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
J610	9-80084E01	connector, receptacle: female, single contact
J650	9-80256E01	female, 2 contact
U600	51-80110E01	integrated circuit: (see note) power amplifier module (hybrid)
		mechanical parts
	3-10943M11	SCREW, tapping: TT3 × 0.5 × 10; 9 used
	26-80057E01	HEAT SINK, PA
	42-80150E01	CLIP, ground
	42-80150E02	CLIP, ground
	4-5131974	WASHER, flat (2 used)

note: For optimum performance, diodes, transistors, and integrated circuits must be ordered by Motorola part numbers.



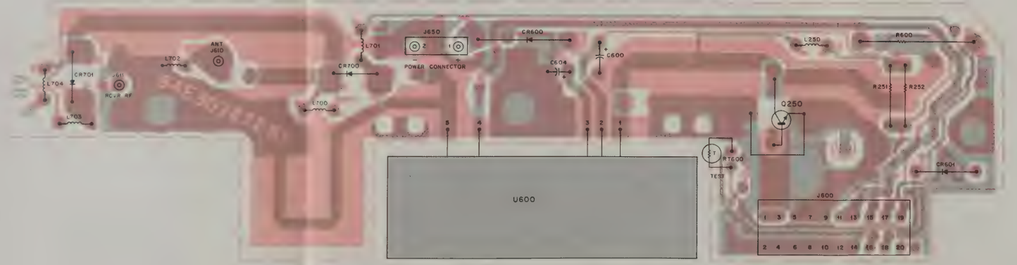
(NOTE: COMPONENTS ARE CHIP TYPE)

SHOWN FROM SOLDER SIDE

COMPONENT SIDE VIEW DEPS-35464-O (REVERSED)

SOLDER SIDE VIEW DEPS-35465-O (REVERSED)

OVERLAY DEPS-35467-O



COMPONENT SIDE DEPS-35464-O

SOLDER SIDE DEPS-35465-O

OVERLAY DEPS-35466-A

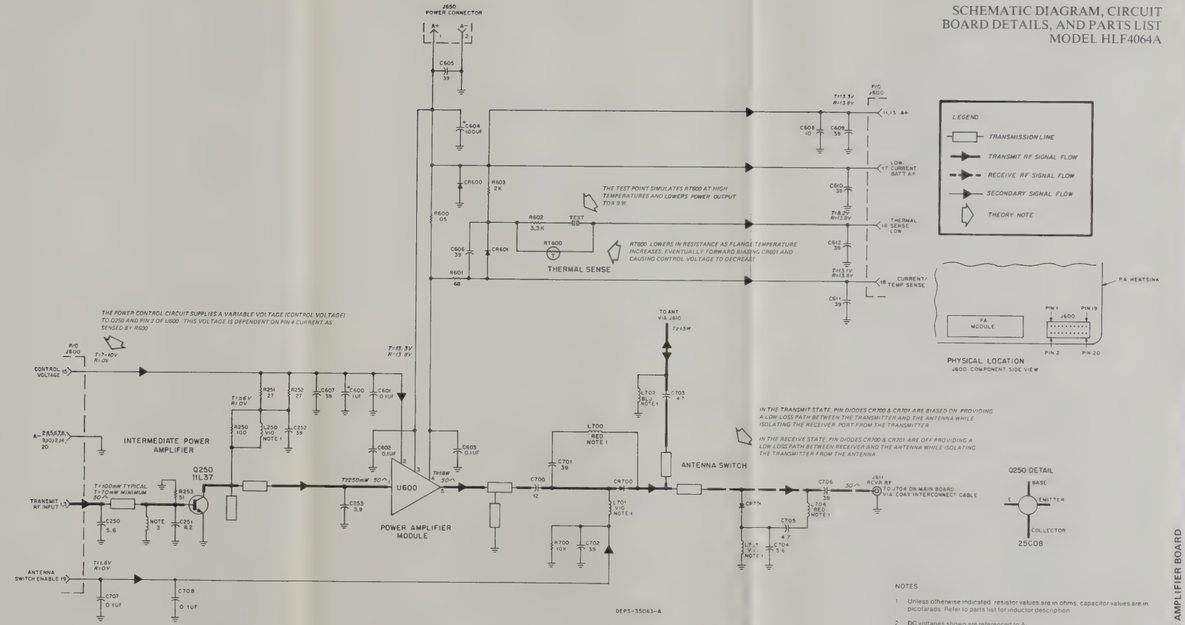
Q250 DETAIL

B
E
E
C

TYPE 11L37

POWER AMPLIFIER BOARD

SCHEMATIC DIAGRAM, CIRCUIT BOARD DETAILS, AND PARTS LIST MODEL HLF4064A



NOTES

1. Unless otherwise indicated: resistor values are in ohms, capacitor values are in picofarads. Refer to parts list for inductor description
2. DC voltages shown are referenced to A-
3. This inductor is actually part of the circuit board foil

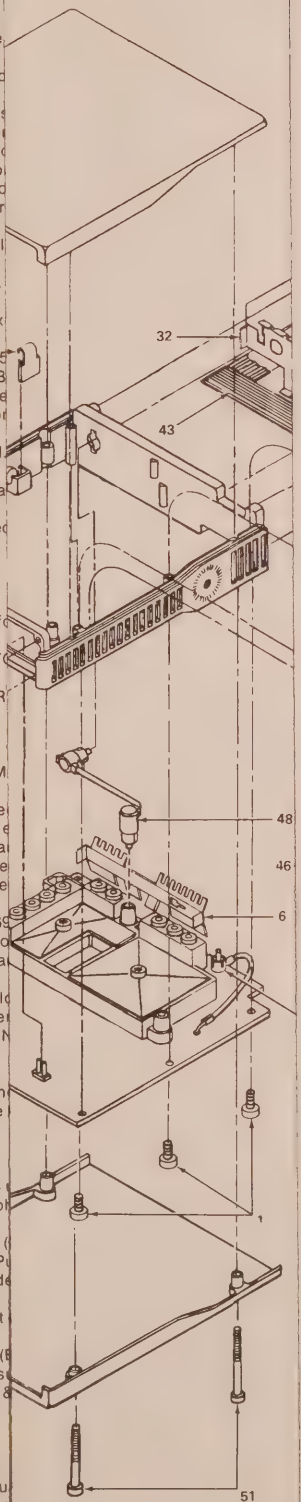
68P81063E44-A
2/10/84-PH

POWER AMPLIFIER BOARD

parts list

Mostar Trunked Radio Set Mechanical Parts List

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCR
1	3-10943M11	SCREW, machine: M3
2	15-80038E01	COVER, mixer
3	15-80040E01	COVER, buffer double
4	32-80171F01	GASKET, rf deck
5	14-80196F01	INSULATOR, 2-cell
6	42-80178F01	CLIP, grounding; rf dec
7	15-80033E01	HOUSING, filter; 800 M
8	15-80075F01	COVER, rf connector
9	39-80065F01	CONTACT, rf
10	15-80174F01	CONNECTOR, rf
11	4-131974	WASHER, flat; 2 used
12	15-80034E02	COVER, 2 cell
13	15-80035E02	COVER, 3 cell
14	15-80036E02	COVER, 4 cell
15	32-80172F01	GASKET, rf deck
16	HLF4063A	MAIN BOARD (for refe
17	15-80039E01	COVER, filter; bottom
18	26-80144E01	SHIELD, IF coil; 2 used
19	26-80237E01	SHIELD
20	5-84220B01	GROMMET, nylon; 5 us
21	26-80142E01	SHIELD, 10.7 IF; botto
22	26-80145E01	SHIELD, local oscillato
23	26-80143E01	SHIELD, quad detecto
24	3-80136F01	SCREW, metric high/lo
25	36-80120D02	KNOB, subfleet contr options)
26	36-80120D01	KNOB, system control
27	36-80118D01	KNOB, control
28	38-80129D02	S1603 BUTTON, PA options)
	38-80129D03	S1603 BUTTON, ex option)
	38-80129D13	S1604 BUTTON, I/E (B5
	38-80129D14	S1604 BUTTON, A/B (B
	38-80129D15	S1602 BUTTON, vol. se
	38-80129D17	S1604 BUTTON, pr options)
	38-80129D18	S1602 BUTTON, tel option)
29	7-80211E01	SUPPORT, control sha
30	27-80054E01	CHASSIS, frame
31	42-80074D01	CLIP, mounting; 4 used
32	26-80058E02	SHIELD, PA
33	15-80055E02	HOUSING, top cover
34	42-80150E01	CLIP, grounding
35	42-80150E02	CLIP, grounding
36	HLF4064A	POWER AMP, board (f
37	3-10943M25	SCREW, machine: M4
38		ANTENNA CONNECT hardware parts list)
39		POWER CONNECTOR hardware parts list)
40	26-80057E01	HEAT SINK, PA
41	33-80080E01	NAMEPLATE, FCC
42		POWER AMPLIFIER M hardware parts list)
43	30-80245E01	P707 and J709 (see ele
44	30-80068D01	P700 (with cable) (see e
45	30-80031E01	P703 (see electrical pa
46	42-81053F01	RETAINER, strain relie
47	48-80094D01	SWITCH, S1600, se options)
		S1601 (B346, B705, B69
48	30-80032E01	P704 and P611 (with co
49	30-80031E01	P702 (see electrical pa
50	15-80056E05	HOUSING, bottom
51	3-80076E01	SCREW, metric: high/lo
52	HLF4063A	MAIN BOARD (for refe
53		ON/OFF VOLUME CON board parts list)
54	32-80127D01	GASKET, speaker
55	42-80137F01	RETAINER, speaker m
56		SPEAKER LS100; (see parts list)
57	32-80166F01	GASKET, speaker
58	14-80075D01	INSULATOR; 4 used
59	43-80218E01	SPACER, mounting; 4
60		J500 SOCKET, microp list)
61	HLF4064A	POWER AMP BOARD (
62	40-80183D02	S1602, S1603, S1604 P user specified by mode
63	13-80208E01	BEZEL, standard
	13-80208E02	BEZEL, multi-subfleet options)
	13-80208E03	BEZEL, multi system (B
	13-80208E04	BEZEL multi system/s (combinations of E02 &
64	15-80028E01	COVER, synthesizer
65	3-80059D01	SCREW, set
66	2-80060D01	NUT, jam; 10-32
67	15-80016F01	HOUSING, VCO
68	15-80045F01	FEED-THRU, plate; 5 u
69		COIL, VCO (L1252-se board parts list)



MOSTAR RADIO SET
NICAL EXPLODED VIEW
& PARTS LIST

Motorola No. PEPS-35641-A
2/10/84-PHI

RADIO SET PARTS LISTS

parts list

HLN4410A Hardware Volume Set Kit — PL-8302-O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
	13-80208E01	BEZEL
	36-80118D01	KNOB, control

HLN4383A Housing Kit — PL-8303-O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
	3-80076E01	SCREW, metric; high/low; 4 used
	7-80211E01	SUPPORT, control shafts
	15-80055E02	HOUSING, top cover
	15-80056E02	HOUSING, bottom cover
	32-80127D01	GASKET, speaker
	33-80080E01	NAMEPLATE, FCC
	54-80112F01	LABEL, user card
	54-80113F01	LABEL, radio

HLN4381A Prom Kit — PL-8304-O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		integrated circuit: (see note)
U1602	51-97001B01	PROM, digital; 256 × 4
		mechanical part
	54-80111F01	LABEL, prom

note: For optimum performance, diodes, transistors, and integrated circuits must be ordered by Motorola part numbers.

HKN4120A Mobile Power Cable — PL-8305-O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		fuse
F1	65-80283E04	7.5 amp; blade type
		mechanical parts
	29-82607B03	LUG, ring tongue; 2 used
	30-80147D01	CABLE, power
	30-80214F01	CABLE, power adapter

HLN4489A Hardware Kit — PL-8306-A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		speaker
LS100	50-80085D01	75 × 44 mm, oval
		connector, plug and cable:
JU709	30-80034G01	wire, jumper
P707	30-80245E01	assembly cable, 15 conductor; includes connector
		mechanical parts
	3-10943M11	SCREW, tapping; TT3 × 0.5 × 10; 15 used
	3-10943M25	SCREW, tapping; TT4 × 0.7 × 20; 2 used
	14-80075D01	INSULATOR, 4 used
	15-80005G01	COVER, dust
	26-80058E01	SHIELD, PA heat sink
	30-80089E01	CABLE, speaker
	32-80166F01	GASKET, speaker
	42-80074D01	CLIP, TO220 mounting; 4 used
	42-80112D01	RING, O gasket; 2 used
	42-80137F01	RETAINER, speaker
	42-80145F01	CLIP, option plug

HLN4449A Hardware Volume Kit — PL-8307-O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
S1602	40-80138D02	**switch:** push/push
		mechanical part
	38-80129D15	BUTTON, volume set

HLN4433A Microphone Hang-Up Clip — PL-8309-O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		mechanical parts
	1-80149F01	ASSEMBLY, hang-up clip
	3-139913	SCREW, tapping; 8-18 × 1/2"; 2 used

HLN4385A Chassis Hardware — PL-8308-O

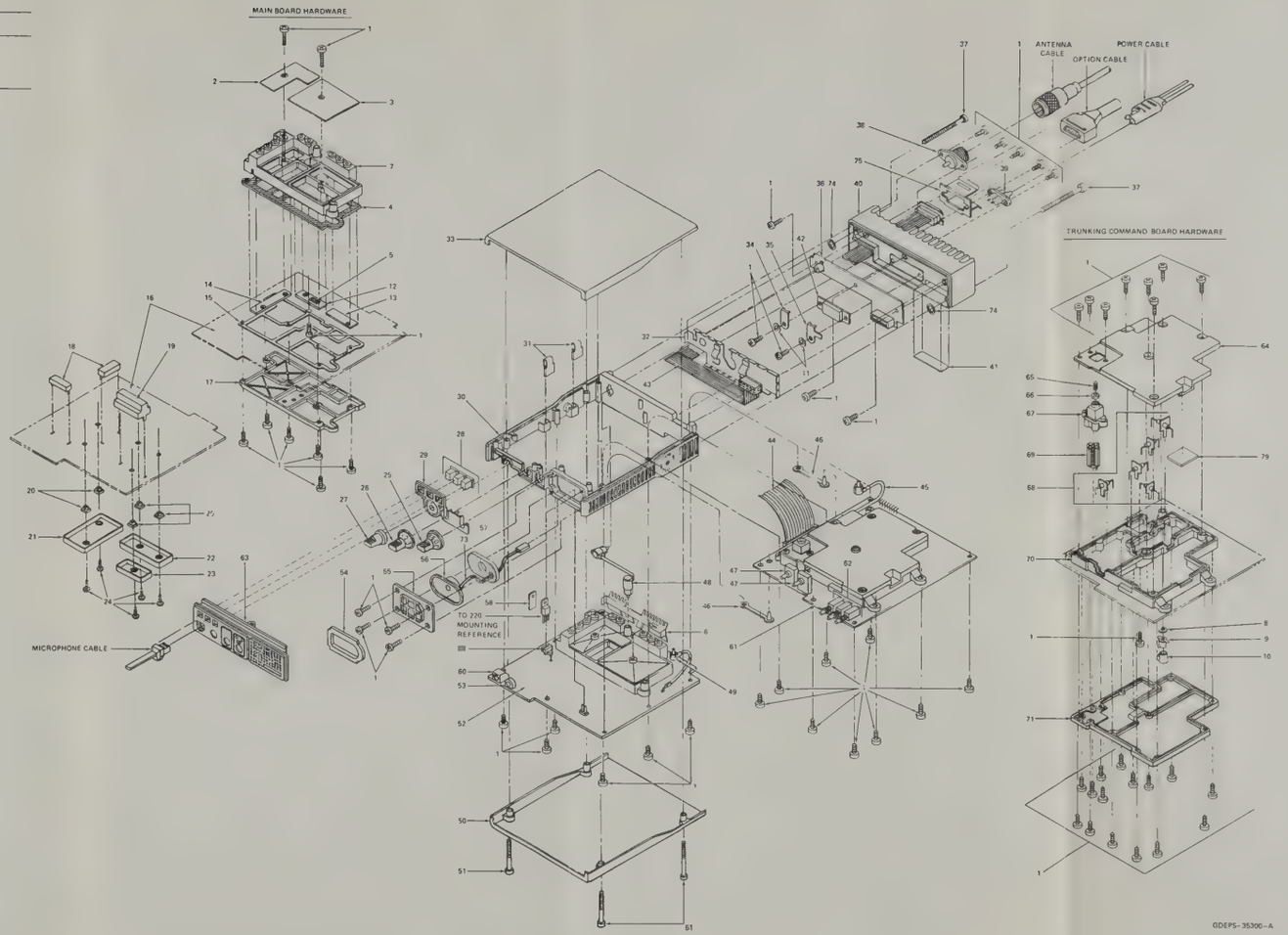
REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
	3-10943M11	SCREW, tapping; TT3 × 0.5 × 10; 7 used
	27-80054E01	CHASSIS, frame
	30-80032E01	CABLE, rf antenna
	42-80153F01	RETAINER, strain relief; 2 used
	42-80178F01	CLIP, rf grounding

Motorola No. PEPS-35639-A
2/10/84-PHI

parts list

Mostar Trunked Radio Set Mechanical Parts List PL-6272-A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
1	3-10943M11	SCREW, machine: M3 × 10.0; 64 used
2	15-80038E01	COVER, mixer
3	15-80040E01	COVER, buffer doubler
4	32-80171F01	GASKET, rf deck
5	14-80196F01	INSULATOR, 2-cell
6	42-80178F01	CLIP, grounding, rf deck
7	15-80033E01	HOUSING, filter; 800 MHz
8	15-80075F01	COVER, rf connector
9	39-80065F01	CONTACT, rf
10	15-80174F01	CONNECTOR, rf
11	4-131974	WASHER, flat; 2 used
12	15-80034E02	COVER, 2 cell
13	15-80035E02	COVER, 3 cell
14	15-80036E02	COVER, 4 cell
15	32-80172F01	GASKET, rf deck
16	HLF4063A	MAIN BOARD (for reference only)
17	15-80039E01	COVER, filter; bottom
18	26-80144E01	SHIELD, IF coil; 2 used
19	26-80237E01	SHIELD
20	5-84220B01	GROMMET, nylon; 5 used
21	26-80142E01	SHIELD, 10.7 IF, bottom
22	26-80145E01	SHIELD, local oscillator
23	26-80143E01	SHIELD, quad detector
24	3-80138F01	SCREW, metric high/low; 5 used
25	36-80120D02	KNOB, subfleet control (B346, B699, B705 options)
26	36-80120D01	KNOB, system control (B305, B709 options)
27	36-80118D01	KNOB, control
28	38-80129D02	S1603 BUTTON, PA (B330, B589, B700 options)
	38-80129D03	S1603 BUTTON, external alarm (B116 option)
	38-80129D13	S1604 BUTTON, I/E (B589 option)
	38-80129D14	S1604 BUTTON, A/B (B488 option)
	38-80129D15	S1602 BUTTON, vol set (standard)
	38-80129D17	S1604 BUTTON, private (B704, B705 options)
	38-80129D18	S1602 BUTTON, tel. interconnect (B20 option)
29	7-80211E01	SUPPORT, control shaft
30	27-80054E01	CHASSIS, frame
31	42-80074D01	CLIP, mounting; 4 used
32	26-80058E02	SHIELD, PA
33	15-80055E02	HOUSING, top cover
34	42-80150E01	CLIP, grounding
35	42-80150E02	CLIP, grounding
36	HLF4064A	POWER AMP, board (for reference only)
37	3-10943M25	SCREW, machine M4 × 20.0; 2 used
38		ANTENNA CONNECTOR J610 (see PA hardware parts list)
39		POWER CONNECTOR J650 (see PA hardware parts list)
40	26-80057E01	HEAT SINK, PA
41	33-80080E01	NAMEPLATE, FCC
42		POWER AMPLIFIER MODULE (see PA hardware parts list)
43	30-80245E01	P707 and J709 (see electrical parts list)
44	30-80068D01	P700 (with cable) (see electrical parts list)
45	30-80031E01	P703 (see electrical parts list)
46	42-81053F01	RETAINER, strain relief; 2 used
47	48-80094D01	SWITCH, S1600, selector (B305, B709 options)
		S1601 (B346, B705, B699 options)
48	30-80032E01	P704 and P611 (with coax cable)
49	30-80031E01	P702 (see electrical parts list)
50	15-80056E05	HOUSING, bottom
51	3-80076E01	SCREW, metric high/low; 4 used
52	HLF4063A	MAIN BOARD (for reference only)
53		ON/OFF VOLUME CONTROL (see main board parts list)
54	32-80127D01	GASKET, speaker
55	42-80137F01	RETAINER, speaker mounting
56		SPEAKER LS100, (see HLN4489A hdw kit parts list)
57	32-80166F01	GASKET, speaker
58	14-80075D01	INSULATOR; 4 used
59	43-80218E01	SPACER, mounting; 4 used
60		J500 SOCKET, microphone (see main parts list)
61	HLF4064A	POWER AMP BOARD (for reference only)
62	40-80183D02	S1602, S1603, S1604 Pushbutton switches; user specified by model or option
63	13-80208E01	BEZEL, standard
	13-80208E02	BEZEL, multi-subfleet (B346, B699, B705 options)
	13-80208E03	BEZEL, multi system (B305, B709 options)
	13-80208E04	BEZEL multi system/subfleet (combinations of E02 & E03 options)
64	15-80028E01	COVER, synthesizer
65	3-80059D01	SCREW, set
66	2-80060D01	NUT, jam; 10-32
67	15-80016F01	HOUSING, VCO
68	15-80045F01	FEED-THRU, plate; 5 used
69		COIL, VCO (L1252-see trunked/command board parts list)
70	15-80027E01	HOUSING, synthesizer
71	15-80029E02	COVER, bottom; synthesizer
73	30-80089E01	CABLE, speaker
75	42-80145F01	CLIP, option retainer
79	75-82200H01	PAD, rubber



MOSTAR RADIO SET MECHANICAL EXPLODED VIEW & PARTS LIST

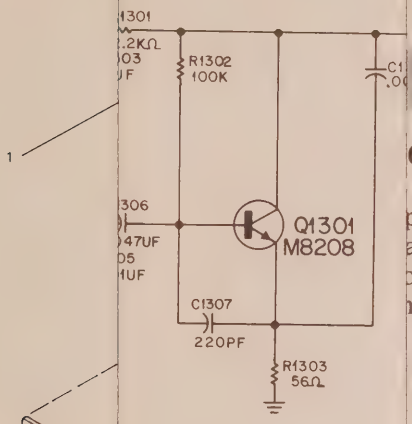
MOSTAR RADIO SET

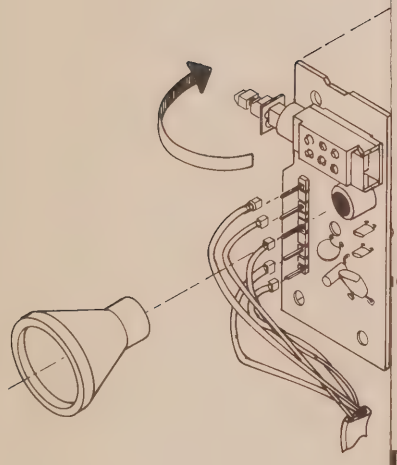
Motorola No. PEPS-35641-A
2/10/84-PHI

PALM MICROPHONE

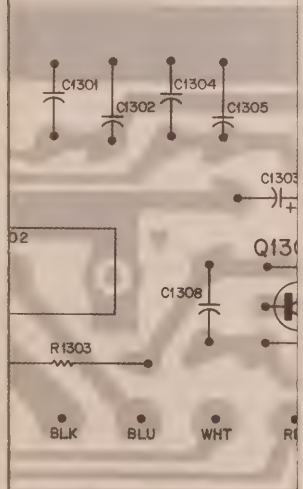
MODEL HMN1001A

EMATIC DIAGRAM





IT BOARD DETAIL



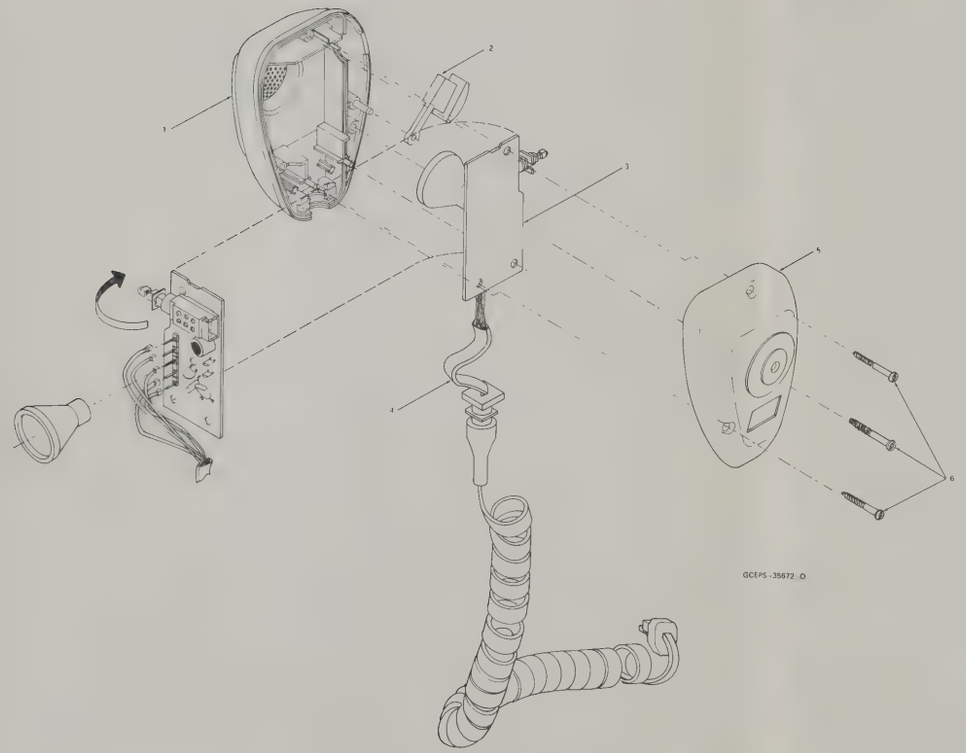
OMPONENT SIDE

CTION

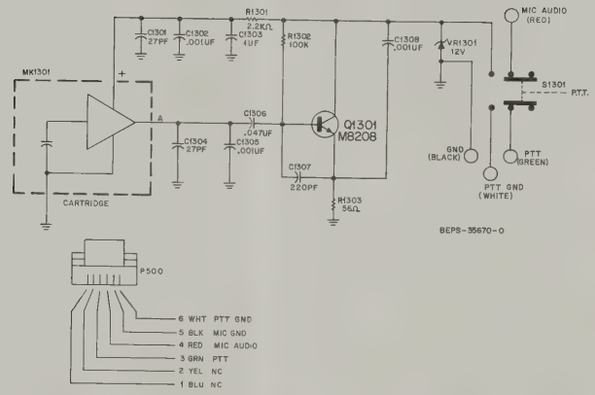
palm microphone contains an amplifier to provide adio with a high-level, noise-free audio input. The ophone also provides push-to-talk transmit control he radio.

68P81063E46-O
1/7/83-PHI

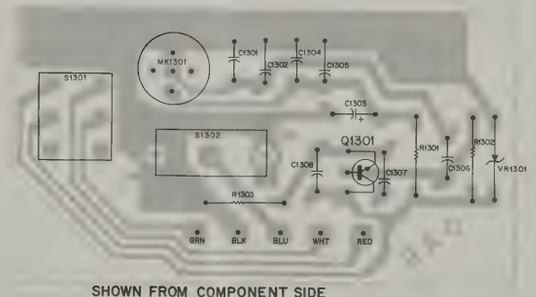
EXPLODED VIEW



SCHEMATIC DIAGRAM



CIRCUIT BOARD DETAIL



SHOWN FROM COMPONENT SIDE

80-BEPS-35669-O
OL-BEPS-35668-O

PALM MICROPHONE

MODEL HMN1001A

parts list

HLN4384A Microphone Board — PL-8246-O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		capacitor, fixed: uF ± 5%; 50 V: unless otherwise stated
C1301	21-11038H35	27 pF
C1302	21-11039B13	1000 pF; ± 10%
C1303	23-11019A09	1; 20%
C1304	21-11038H35	27 pF
C1305	21-11039B13	1000 pF; ± 10%
C1306	8-11017A14	.047
C1307	21-11038P50	220 pF
C1308	21-11039B13	1000 pF; ± 10%
		diode: (see note)
CR1301	48-80007E02	Zener; 12 V ± 5%
		cartridge:
MK1301	50-80068E01	microphone; electret
		transistor:
Q1301	41-80182D08	NPN; type M8208
		resistor, fixed: ± 5%; 1/4 W:
R1301	6-11009A57	2200
R1302	6-11009A97	100k
R1303	6-11009A19	56
		switch:
S1301	40-80065E01	momentary; pushbutton type
		non-referenced items
	28-80085E07	CONNECTOR, header; male; 5 pin
	5-80148D01	GROMMET, microphone cartridge

HLN4416A Microphone Hardware Kit — PL-8247-O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
1	15-80137D04	HOUSING, microphone; front
2	38-80144D01	BUTTON; switch
3	HLN4384	CIRCUIT BOARD
4	30-80146D01	CABLE; coiled microphone
5	1-80710T70	HOUSING, microphone; rear
6	3-80076E02	SCREW, captive; 3 used

note: For optimum performance, diodes, transistors, and integrated circuits must be ordered by Motorola part numbers.

FUNCTION

The palm microphone contains an amplifier to provide the radio with a high-level, noise-free audio input. The microphone also provides push-to-talk transmit control for the radio.

68P81063E46-O
1/7/83-PHI

MOTOROLA

USER QUESTIONNAIRE

To the User of This Instruction Manual:

Motorola is engaged in a continuous program of improving its instruction literature. We believe that you can aid us in this program, so that we in turn can better help you service our equipment. To foster these aims, would you please answer the following questions:

SCHEMATIC DIAGRAMS AND CABLING DIAGRAMS

1. ☐ Are accurate and easy to follow
2. ☐ Contain minor errors
3. ☐ Contain major errors
4. ☐ Are difficult to follow

If you have checked any box except 1, please tell us what schematic diagrams, or portions thereof, were at fault, or enter other comments.*

_____

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TEXT

1. ☐ Easy to follow — helps to service equipment
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_____

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3. ☐ Some instruction sections are too long or superfluous such as*

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(continued on reverse side)

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AVAILABLE BACKGROUND REFERENCE PUBLICATIONS

Five reference publications are available to provide background information needed to service some of the newer Motorola products more effectively. The information in these publications is not duplicated in our instruction manuals. To obtain your free copy, check the ones you want and return this self-mailer to us. (NOTE: One copy of each publication has already been distributed to Motorola Service Shops (MSS's) and field technical representatives (FTR's).

Check item desired:

☐ **Basic Logic Circuit Guide** — 68P81105E88
Describes the basic logic circuits used in Motorola Communications digital equipment and the logic notational scheme used in our instruction manuals.

☐ **"Digital Private-Line" Binary-Coded Squelch** — 68P81106E83
Contains fundamentals of "Digital Private-Line" system operation, circuit operation and servicing techniques.

☐ **Safe Handling of CMOS Integrated Circuit Devices** — 68P81106E84
Describes special handling techniques needed to prevent irrepairable damage from static charges encountered with normal handling of CMOS devices.

☐ **Reducing Noise Interference in Mobile Two- Way Radio Installations** — 68P81109E33
Defines the major sources of noise encountered in a mobile radio installation and suggests methods of remedying them.

☐ **Anti-Skid Braking Precautions** — 68P81109E34
Provides installation suggestions and a detailed checkout procedure for installation of mobile radios in vehicles with anti-skid braking systems.

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Receive: 851-870 MHz
15 W RF Power

68P81062E65-A

MOTOROLA
Mobile Products Division

instruction manual revision

GENERAL

This revision consists of changes that have occurred since your instruction manual was printed. Please correct your manual accordingly.

INSTRUCTION MANUAL AFFECTED

68P81114E07-B — *Touch-Code* Encoder Palm Microphone Instruction Manual

REVISION DETAILS

This revision adds the DTMF Microphone Kit for *SPECTRA* radio to the Instruction Manual.

1. Locate the Model Chart page (MXW-2776-O). Tape, paste, or staple the attached revised Model Chart (MXW-2776-A) over the old chart.

2. Locate the Exploded View and Parts List foldout page (PEPS-36480-B). In the box showing details of the microphone cord for item 7F, add the part number 30-80223J06.

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WMR-0285
9/24/87

Model Chart for *Touch-Code* Encoder Palm Microphone

CODE:

● = ONE ITEM SUPPLIED

ITEM	DESCRIPTION	HMN1010B	HMN1011B	HMN1024B	HMN1014B	HMN1022B	HMN1032A	HMN1018B	HMN1019B	HMN1020B	HMN1033A	HMN1034A	HMN1021B	HMN1023B	HMN1025B	HMN1026B	HMN1053A
HLN4530A	KEYPAD	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
HLN1120B	LOGIC AND BEEPER BOARD ASSEMBLY	●	●	●	●	●	●	●	●	●	●	●	●	●	●		●
HLN1155A	LOGIC AND BEEPER BOARD ASSEMBLY															●	
HLN4522B	LOGIC BOARD	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
HLN4523B	BEEPER BOARD	●	●	●	●	●	●	●	●	●	●	●	●	●	●		●
HLN4775A	BEEPER BOARD															●	
HLN4556B	MICROPHONE HARDWARE	●															
HLN4678B	MICROPHONE HARDWARE		●														
HLN4677B	MICROPHONE HARDWARE			●													
HLN4590B	MICROPHONE HARDWARE				●												
HLN4638B	MICROPHONE HARDWARE					●											
HLN4996B	MICROPHONE HARDWARE						●										
HLN4634B	MICROPHONE HARDWARE							●									
HLN4635B	MICROPHONE HARDWARE								●								
HLN4636B	MICROPHONE HARDWARE									●							
HLN5007A	MICROPHONE HARDWARE										●						
HLN5006A	MICROPHONE HARDWARE											●					
HLN4637B	MICROPHONE HARDWARE												●				
HLN4676B	MICROPHONE HARDWARE													●			
HLN4679B	MICROPHONE HARDWARE														●		
HLN4680B	MICROPHONE HARDWARE															●	
HLN6045A	MICROPHONE HARDWARE																●
30-80223J06	MICROPHONE CABLE (ITEM 7F, EXPLODED VIEW)																●
30-80146D01	MICROPHONE CABLE (ITEM 7, EXPLODED VIEW)	●	●	●													
30-80147H02	MICROPHONE CABLE (ITEM 7A, EXPLODED VIEW)				●	●		●	●				●				
30-80223J02	MICROPHONE CABLE (ITEM 7F, EXPLODED VIEW)						●										
30-80199G01	MICROPHONE CABLE (ITEM 7B, EXPLODED VIEW)									●							
30-80018G03	MICROPHONE CABLE (ITEM 7E, EXPLODED VIEW)										●	●					
30-80198G01	MICROPHONE CABLE (ITEM 7C, EXPLODED VIEW)												●				
30-80222G01	MICROPHONE CABLE (ITEM 7D, EXPLODED VIEW)													●			
30-80222G02	MICROPHONE CABLE (ITEM 7D, EXPLODED VIEW)														●		
01-80738T96	MICROPHONE HANGUP CLIP	●	●		●			●				●					
01-80743T05	MICROPHONE HANGUP CLIP, *PRIVATE-LINE*			●			●				●			●	●	●	

MOTOROLA
Mobile Products Division

GENERAL

This revision consists of changes that have occurred sin
your manual accordingly.

INSTRUCTION MANUAL AFFECTED

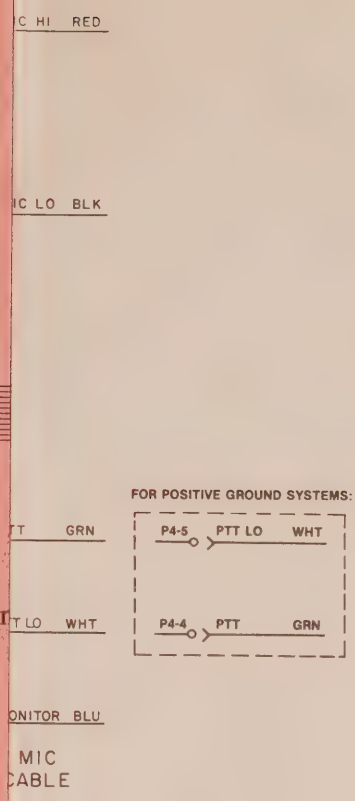
68P81114E07-B

REVISION DETAILS

This document includes a schematic that has been revised
ground system.

Remove Sheet 2 of 2 foldout page, PEPS-36482-B (Schema
and HLN4775A, Microphone and Beeper Boards).

Insert the attached foldout page, PEPS-36482-C (Sheet



NOTES:

1. HLN4523B Microphone and Beeper Board Resistor, Diode, and Jumper Table.

MODEL	R18	R19	JU1	CR9
HMN1010B	OUT	IN	IN	OUT
HMN1011B	750 Ω	OUT	OUT	IN
HMN1014B	8.2k	IN	OUT	OUT
HMN1018B	750 Ω	OUT	OUT	OUT
HMN1019B				
HMN1020B	750 Ω	OUT	OUT	OUT
HMN1021B	750 Ω	OUT	OUT	OUT
HMN1022B	OUT	IN	IN	OUT
HMN1023B	750 Ω	OUT	OUT	IN
HMN1024B	750 Ω	OUT	OUT	IN
HMN1025B				
HMN1032A	OUT	IN	IN	OUT
HMN1033A	750 Ω	OUT	OUT	IN
HMN1034A	750 Ω	OUT	OUT	IN

2. HLN4775A Microphone and Beeper Board Resistor, Diode, and Jumper Table.

MODEL	R19	R18	JU1	R4	CR9
HMN1026B	OUT	1.5k	OUT	IN	OUT

3. Monitor switch circuitry in dashed box is operation for Models HMN1023B, HMN1024B, HMN1026B, HMN1032A, and HMN1033A only.

4. Voltages indicated in (0.2V) are active voltages (when either PTT or keypad buttons are pressed). Standby voltages are shown without parenthesis.

5. Unless otherwise indicated, resistor values are in ohms, and capacitor values are in microfarads.

6. JU6 is not used.

7. The ground symbol on this diagram is actually referenced to microphone low, not to radio ground.

8. For postive ground systems:
   (a) connect GRN (PTT) wire to P4-4.
   (b) connect WHT (PTT LO) wire to P4-5.
   (c) JU1 must be "in".

Schematic, Circuit Board Diagrams, and
Parts List for HLN4523B and HLN4775A
Microphone and Beeper Boards
PEPS-36482-C
(Sheet 2 of 2)
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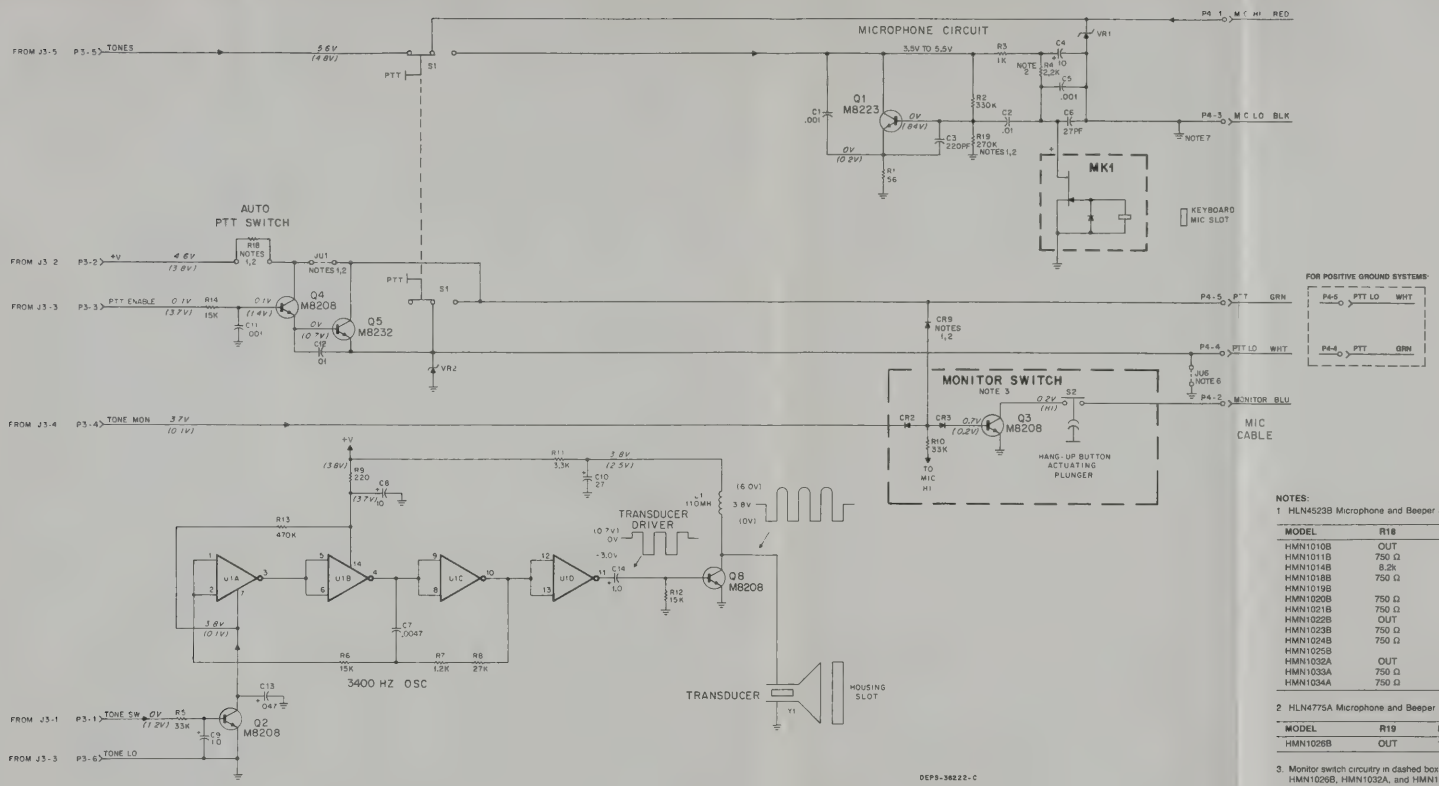

NOTES:

1 HLN4523B Microphone and Beeper Board Resistor, Diode, and Jumper Table

MODEL	R18	R19	JU1	R4	CR9
HMN1010B	OUT	IN	IN		OUT
HMN1011B	750 Ω	OUT	OUT		IN
HMN1014B	8.2k	IN	OUT		OUT
HMN1018B	750 Ω	OUT	OUT		OUT
HMN1019B					
HMN1020B	750 Ω	OUT	OUT		OUT
HMN1021B	750 Ω	OUT	OUT		OUT
HMN1022B	OUT	IN	IN		OUT
HMN1023B	750 Ω	OUT	OUT		IN
HMN1024B	750 Ω	OUT	OUT		IN
HMN1025B					
HMN1032A	OUT	IN	IN		OUT
HMN1033A	750 Ω	OUT	OUT		IN
HMN1034A	750 Ω	OUT	OUT		IN

2 HLN4775A Microphone and Beeper Board Resistor, Diode, and Jumper Table

MODEL	R19	R18	JU1	R4	CR9
HMN1026B	OUT	1.5k	OUT	IN	OUT

3. Monitor switch circuitry in dashed box is operation for Models HMN1023B, HMN1024B, HMN1026B, HMN1032A, and HMN1033A only

4 Voltages indicated in (0 2V) are active voltages (when either PTT or keypad buttons are pressed) Standby voltages are shown without parenthesis

5 Unless otherwise indicated, resistor values are in ohms, and capacitor values are in microfarads

6 JU6 is not used

7. The ground symbol on this diagram is actually referenced to microphone low, not to radio ground

8. For postive ground systems:
   (a) connect GRN (PTT) wire to P4-4
   (b) connect WHT (PTT LO) wire to P4-5.
   (c) JU1 must be "in"

Schematic, Circuit Board Diagrams, and Parts List for HLN4523B and HLN4775A Microphone and Beeper Boards
PEPS-36482-C
(Sheet 2 of 2)
9/17/86

MOTOROLA
Mobile Products Division

instruction manual revision

Addendum to WMR-0285

GENERAL

This revision contains information covering the *SPECTRA* DTMF microphone option. Add this information to your manual as instructed below.

INSTRUCTION MANUAL AFFECTED

68P81114E07-B — *Touch-Code* Encoder Palm Microphone Instruction Manual

REVISION DETAILS

Locate the foldout page for the Schematic, Circuit Board Diagrams, and Parts List for Microphone and Beeper Boards, PEPS-36482-C. On the right side of Sheet 2, tape, paste, or staple the attached, revised "NOTES" over the existing NOTES.

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WMR-0311
11/6/87

NOTES:

1. HLN4523B Microphone and Beeper Board Resistor, Diode, and Jumper Table.

MODEL	R18	R19	JU1	CR9
HMN1010B	OUT	IN	IN	OUT
HMN1011B	750 OHM	OUT	OUT	IN
HMN1014B	8.2k	IN	OUT	OUT
HMN1018B	750 OHM	OUT	OUT	OUT
HMN1019B				
HMN1020B	750 OHM	OUT	OUT	OUT
HMN1021B	750 OHM	OUT	OUT	OUT
HMN1022B	OUT	IN	IN	OUT
HMN1023B	750 OHM	OUT	OUT	IN
HMN1024B	750 OHM	OUT	OUT	IN
HMN1025B				
HMN1032A	OUT	IN	IN	OUT
HMN1033A	750 OHM	OUT	OUT	IN
HMN1034A	750 OHM	OUT	OUT	IN
HMN1053A	OUT	IN	IN	OUT

2. HLN4775A Microphone and Beeper Board Resistor, Diode, and Jumper Table.

MODEL	R18	R19	JU1	CR9	R4
HMN1026B	1.5k	OUT	OUT	OUT	IN

3. Monitor switch circuitry in dashed box is operational for Models HMN1023B, HMN1024B, HMN1032A, HMN1033A, and HMN1053A only.

4. Voltages shown in parenthesis, e.g. (0V), are active voltages when either the PTT or keypad buttons are pressed. Standby voltages are shown without parenthesis.

5. Unless otherwise specified, resistor values are in ohms, and capacitor values are in microfarads.

6. JU6 is not used.

7. The ground symbol on this diagram is actually referenced to microphone low, not to radio ground.

8. For positive ground systems:
   (a) connect GRN (PTT) wire to P4–4.
   (b) connect WHT (PTT LO) wire to P4–5.
   (c) JU1 must be "IN".

MOTOROLA

Touch-Code Encoder Palm Microphone

Instruction Manual

68P81114E07-B

MOTOROLA
Mobile Products Division

Touch-Code Encoder Palm Microphone

Contents

Diagrams

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Model Chart for *Touch-Code* Encoder Palm Microphone

CODE:

● = ONE ITEM SUPPLIED

MODEL	DESCRIPTION	ITEM	DESCRIPTION
HMN1010B	*MOSTAR* TRUNKED 800 MHz	HLN4530A	KEYPAD
HMN1011B	*MOSTAR* UHF/VHF, CARRIER SQUELCH	HLN1120B	LOGIC AND BEEPER BOARD ASSEMBLY
HMN1024B	*MOSTAR* UHF/VHF, *PRIVATE-LINE*	HLN1155A	LOGIC AND BEEPER BOARD ASSEMBLY
HMN1014B	*SYNTOR* TRUNKED	HLN4522B	LOGIC BOARD
HMN1022B	*SYNTOR* NON-TRUNKED	HLN4523B	BEEPER BOARD
HMN1032A	*SYNTOR X* 9000, *PRIVATE-LINE*	HLN4775A	BEEPER BOARD
HMN1018B	*MITREK/MOTREK*	HLN4556B	MICROPHONE HARDWARE
HMN1019B	*CONVERTA-COM*	HLN4678B	MICROPHONE HARDWARE
HMN1020B	*MAXAR/MOXY*	HLN4677B	MICROPHONE HARDWARE
HMN1033A	*MAXAR 50* UHF/VHF, *PRIVATE-LINE*	HLN4590B	MICROPHONE HARDWARE
HMN1034A	*MAXAR 50* UHF/VHF, CARRIER SQUELCH	HLN4638B	MICROPHONE HARDWARE
HMN1021B	*MAXAR 80*	HLN4996B	MICROPHONE HARDWARE
HMN1023B	*MCX-100, PRIVATE-LINE* DASH	HLN4634B	MICROPHONE HARDWARE
HMN1025B	*MCX-100*, CARRIER SQUELCH REMOTE	HLN4635B	MICROPHONE HARDWARE
HMN1026B	*MCX-100, PRIVATE-LINE* REMOTE	HLN4636B	MICROPHONE HARDWARE
		HLN5007A	MICROPHONE HARDWARE
		HLN5006A	MICROPHONE HARDWARE
		HLN4637B	MICROPHONE HARDWARE
		HLN4676B	MICROPHONE HARDWARE
		HLN4679B	MICROPHONE HARDWARE
		HLN4680B	MICROPHONE HARDWARE
		30-80146D01	MICROPHONE CABLE (ITEM 7, EXPLODED VIEW)
		30-80147H02	MICROPHONE CABLE (ITEM 7A, EXPLODED VIEW)
		30-80223J02	MICROPHONE CABLE (ITEM 7F, EXPLODED VIEW)
		30-80199G01	MICROPHONE CABLE (ITEM 7B, EXPLODED VIEW)
		30-80018G03	MICROPHONE CABLE (ITEM 7E, EXPLODED VIEW)
		30-80198G01	MICROPHONE CABLE (ITEM 7C, EXPLODED VIEW)
		30-80222G01	MICROPHONE CABLE (ITEM 7D, EXPLODED VIEW)
		30-80222G02	MICROPHONE CABLE (ITEM 7D, EXPLODED VIEW)
		01-80738T96	MICROPHONE HANGUP CLIP
		01-80743T05	MICROPHONE HANGUP CLIP, *PRIVATE-LINE*

GENERAL

Operating Temperature Range	−30°C to +70°C
Standby Voltage	5.5V ±1V
Operating Voltage (PTT pressed)	5.5V ±2.5V
Microphone Output	215 mV ±4.5 dB @ 1 kHz @ 104 dB sound pressure level (300 mV ±4.5 dB for HMN1026B only)

TOUCH-CODE PERFORMANCE

Operating Voltage (key pressed)	5.0V ±1.0V
Auto-PTT On Voltage (key pressed)	Less than 0.6V (HMN1018B, HMN1020B, HMN1021B, HMN1023B, HMN1026B, HMN1014B) Less than 0.7V (HMN1033A, HMN1034A) Less than 0.8V (HMN1010B) Less than 2.5V (HMN1022B, HMN1032A)
Frequency Stability	±1% (−30°C to +70°C, +25°C reference)
Maximum Output Level	225 mV minimum @ 941 Hz
Tone Distortion	Less than 5% @ 160 mV
Beeper Output	Greater than 75 dB sound pressure level
Beeper Frequency	3450 Hz ±600 Hz
Auto PTT Hold Time	1.4 sec. (2.5 sec. optional) ±20%
*, # Timing	0.5 sec. (1.25 sec. optional) ±20% (HMN1010B, HMN1014B)
Digit Timing	110 msec. ±25 msec. (HMN1010B, HMN1014B)
First Digit Delay	500 msec. ±250 msec. (HMN1010B, HMN1014B)

SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE

Foreword

1. Scope of Manual

This manual is intended for the use of experienced technicians familiar with this general type of equipment. In it you should be able to find all the information you will need for installing and servicing the equipment it covers. It is current as of the publication date, and incorporates changes that have occurred since then in the form of instruction manual revisions (WMR's). (WMR's that cover production or engineering changes to the circuitry usually include corrected schematics and circuit board diagrams.)

2. Model and Kit Identification

Each Motorola product has an identifying model number stamped on its nameplate. In most cases, assemblies and kits that make up the product also have identifying kit numbers stamped on them. Schematics and circuit board diagrams for such kits show this same identifying number prominently in the lower lefthand or righthand corner.

3. Service

Motorola's national service organization maintains one of the finest nation-wide installation and maintenance programs available to users of communication equipment. The administrative staff of this organization consists of national, area, and district service managers, all of whom are Motorola employees dedicated to giving our customers the best possible service. The organization has about 900 authorized Motorola Service Stations (MSS's) throughout the United States, each manned by one or more trained, FCC-licensed technicians.

Motorola selected each one of these independently owned and operated MSS's to service its customers. They offer Motorola maintenance either by the job (priced by time and material), or on a service contract at a fixed periodic fee.

To buy a service contract for your Motorola equipment, contact your Motorola Service Representative or write to:

National Service Manager
Motorola Communications and Electronics, Inc.
1303 E. Algonquin Road
Schaumburg, Illinois 60196

4. Ordering Replacement Parts

Motorola maintains a number of area parts offices throughout the United States. These facilities have skilled staff to process orders for parts, identify part numbers, and otherwise assist in the maintenance and repair of Motorola Communications Sector products.

Order manuals and all parts except crystals, active filters, channel elements, and *Vibrasender* and *Vibrasponder* resonant reeds from the nearest area parts office.

When ordering replacement parts or requesting information about equipment, include the complete identification numbers. This applies to all components, kits, and chassis. If you do not know the part number for a component, include the part number of the chassis or kit of which it is a part, and identify the component with a full and accurate description.

Send orders for crystals, channel elements, active filters, and reeds to the Component Product Sales & Service Office (address on next page). When ordering crystals and channel elements, specify the type number, the crystal and carrier frequencies, and the model number of the chassis in which the part is used.

When ordering active filters and *Vibrasender* and *Vibrasponder* resonant reeds, specify the type by number and the frequency, identify the owner or operator of the system in which these items are to be used, and give any serial numbers stamped on the components to be replaced.

Component Product Sales & Service Office

All Mail Orders:
Motorola, Inc.
Component Product Sales & Service
P.O. Box 66191
O'Hare International Airport
Chicago, IL 60666

Correspondence:
Motorola, Inc.
Component Product Sales & Service
2553 N. Edgington Street, Franklin Park, IL 60131
Phone 312-451-1297, TWX 910-227-0799
Telex 433-0067

Area Parts Offices

Western Area Parts
1170 Chess Drive, Foster City, CA 94404
Phone 415-349-8621, TWX 910-375-3877

Rocky Mountain Area Parts
20 Inverness Place East, Englewood, CO 80112
Phone 303-790-2323, TWX 920-935-0785

Pacific-Southwestern Area Parts
P.O. Box 85036, San Diego, CA 92138
Street Address:
9980 Carroll Canyon Road, San Diego, CA 92131
Phone 619-578-8030, TWX 910-335-1516

Southwestern Area Parts
P.O. Box 34290
3320 Belt Line Road, Dallas, TX 75234
Phone 214-620-8511, TWX 910-860-5505

Midwest Area Parts
1313 E. Algonquin Road, Schaumburg, IL 60196
Phone 312-576-7430, TWX 910-693-0869

Southeastern Area Parts
P.O. Box 368, Decatur, GA 30031
Street Address:
5096 Panola Industrial Blvd., Decatur, GA 30032
Phone 404-987-2232, TWX 810-766-0876

Gulf States Area Parts
P.O. Box 73115
1140 Cypress Station, Houston, TX 77090
Phone 713-537-3636, TWX 910-881-6392

East Central Area Parts
12955 Snow Road, Parma, OH 44130
Phone 216-433-1560, TWX 810-427-9424

Eastern Area Parts
85 Harristown Road, Glen Rock, NJ 07452
Phone 201-447-4000, TWX 710-988-5614

Mid-Atlantic Area Parts
7230 Parkway Drive, Hanover, MD 21076
Phone 301-796-8763, TWX 710-862-1941

National Accounts
Railroads, Airlines, and Telephone Sales
1313 E. Algonquin Road, Schaumburg, IL 60196
Phone 312-576-6512, TWX 910-693-0869

All Canadian Orders
Motorola, Ltd., National Parts Department
3125 Steeles, Ave. E., Willowdale, Ontario M2H 2H6
Phone 416-499-1441, TWX 610-491-1032
Telex 06-526258

National Data Services

1711 West 17th Street, Tempe, AZ 85281
Phone 602-994-6472, TWX 910-951-1334

All Countries Except U.S. & Canada

Motorola, Inc., International Parts Department
1313 E. Algonquin Road
Schaumburg, IL 60196, U.S.A.
Phone 312-576-7241, TWX 910-693-0869
Telex 722443, Cable MOTOL PARTS

General Safety Information

The United States Department of Labor, through the provisions of the Occupational Safety and Health Act of 1970 (OSHA), has established an electromagnetic energy safety standard that applies to the use of this equipment. Proper use of this radio will result in exposure below the OSHA limit. The following precautions are recommended:

DO NOT Operate the transmitter of a mobile radio when someone outside the vehicle is within two feet (0.6 meter) of the antenna.

DO NOT operate the transmitter of a fixed radio (base station, microwave, and rural telephone RF equipment) or marine radio when someone is within two feet (0.6 meter) of the antenna.

DO NOT operate the transmitter of any radio unless all RF connectors are secure and any open connectors are properly terminated.

In addition,

DO NOT operate this equipment near electrical blasting caps or in an explosive atmosphere.

All equipment must be properly grounded according to Motorola installation instructions for safe operation.

All equipment should be serviced only by a qualified technician.

Refer to the appropriate section of the product service manual for additional pertinent safety information.

Installation Safety Warning

Consider the occupants' safety when you choose a location for the radio. Do not mount the radio overhead or on a sidewall unless you take special precautions.

If someone were to remove the radio and fail to latch it properly when replacing it, road shock could bump the radio loose, and the falling radio could in some circumstances cause serious injury to the driver or a passenger.

If you must mount the radio overhead or on a sidewall, give it the added protection of a retaining strap. Custom-made straps are available from Motorola National Parts. Order kit number HLN4698A (for *Mitrek*) or HLN4697A (for *SYNTOR* or *SYNTOR X*).

Warning

For vehicles equipped with electronic anti-skid braking systems, see ''ANTI-SKID BRAKING PRECAUTIONS'' Publication, Motorola Number 68P81109E34.

Warning

To gain full access to the Common Circuits Board for servicing, the regulator heat sink screw must be removed. When operating the radio with the regulator heat sink screw removed, care should be taken to avoid the exposed hot flange.

Warning

It is mandatory that radio installations in vehicles fueled by liquefied petroleum gas conform to the following standard.

National Fire Protection Association standard NFPA 58 applies to radio installations in vehicles fueled by liquefied petroleum (LP) gas with the LP-gas container in the trunk or other sealed-off space within the interior of the vehicles. This standard requires that:

1. Any space containing radio equipment shall be isolated by a seal from the space in which the LP-gas container and its fittings are located.
2. Remote (outside) filling connections shall be used.
3. The container space shall be vented to the outside.

MOTOROLA
Mobile Products Division

Touch-Code Encoder Palm Microphone

1. Description

The *Touch-Code* Encoder Palm Microphone allows transmission of dual-tone, multi-frequency (DTMF) signals that are used for remote signalling application and mobile telephone operations. The models covered in this manual and the units each model is used with are listed in the Model Chart. Each microphone is used in place of the standard palm microphone supplied with the radio. No radio modifications are required.

Normal voice transmission is accomplished by pressing the push-to-talk (PTT) button and speaking into the small opening in the keypad. Pressing any keypad button will generate either continuous or timed (jumper selectable) DTMF tones. At the same time a keypad button is pressed, the automatic push-to-talk circuitry in the microphone is enabled, keying the radio transmitter. A single-frequency beep tone (sidetone) is also generated. This tone provides feedback to indicate the required time a keypad button must be held down for proper system timing when the microphone is operated in the timed DTMF mode.

During DTMF tone transmission, the microphone is disabled to eliminate background noise from interfering with the signalling tones.

2. Installation

The *Touch-Code* Encoder Palm Microphone is a direct replacement for the existing radio palm microphone. For most radios, the microphone plugs into the mating receptacle on the radio or on the control head. *Maxar* and *Moxy* radios, however, have no external microphone connectors. To install a Model HMN1020B *(Maxar/Moxy)* microphone, open the radio and replace each lead of the original microphone with the same color lead from the *Touch-Code* encoder palm microphone.

During installation, check the *Touch-Code* encoder deviation (preset at the factory). See the Maintenance Section of this manual for details.

3. Operation

3.1 MICROPHONE MODE

Operate the DTMF microphone in the normal manner. Hold the microphone about two inches from your lips. Press the PTT button and speak clearly into the opening on the keypad. Release the PTT button to listen.

Note

The Model HMN1023B, utilized with *MCX-100* dash mount radios equipped with *Channel Scan,* must be removed from the hangup clip to ensure proper operation when the scanner is enabled.

3.2 *TOUCH-CODE* MODE

The two models used on trunking products (HMN1010B and HMN1014B) operate in the timed tone mode. All other models operate in the continuous tone mode. *Systems 90* decoders in non-trunked radio systems do not require field modification since the associated models are preset to the continuous tone mode.

3.2.1 Timed Tones Operation (JU3 installed in Position B.)

Select DTMF signal digits by pressing one keypad button at a time. Hold the keypad button down for each digit until the sidetone beep stops. Holding the keypad button down for a longer time does not increase the DTMF tone duration, but releasing it before the sidetone beep stops produces a shortened DTMF signal and may prevent proper digit recognition by the system decoder.

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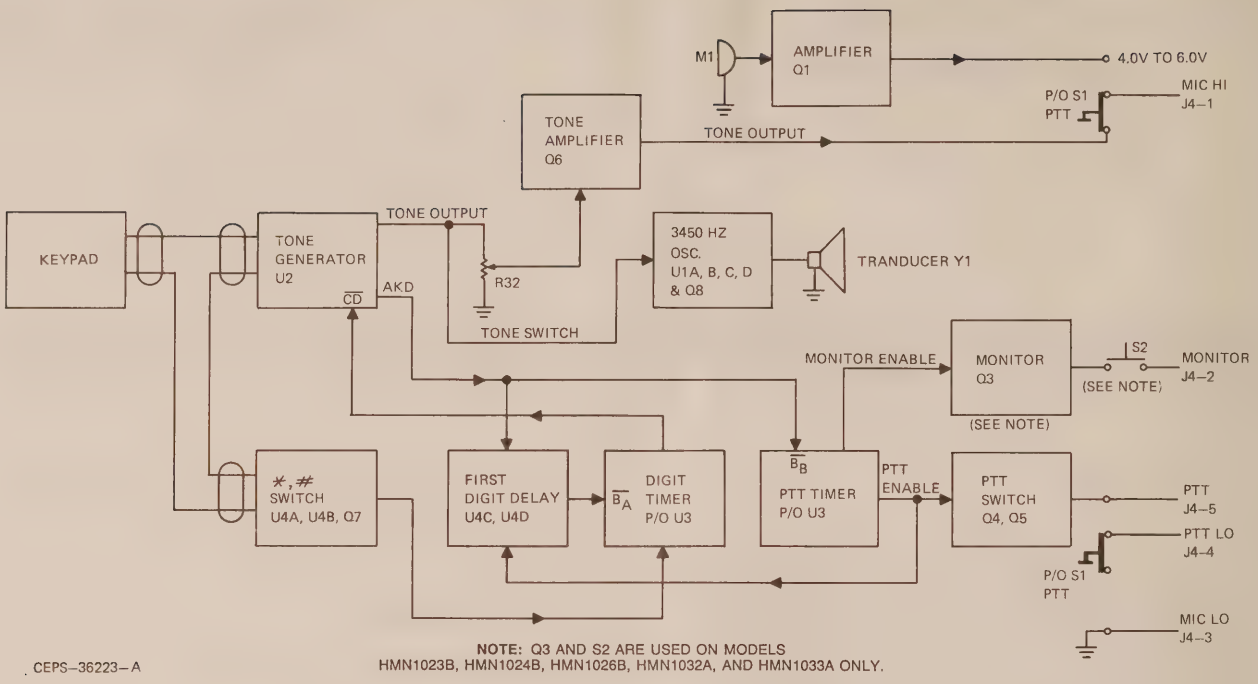


Figure 1. Functional Block Diagram

Note

DO NOT press the microphone PTT button since the auto-push-to-talk circuitry within the microphone enables whenever a keypad button is pressed. Pressing the microphone PTT button and a keypad button at the same time prevents DTMF tone generation.

3.2.2 Continuous Tones Operation (JU3 installed in Position A.)

The keypad and auto-push-to-talk functions are the same as timed-tone operations, but in this mode, the DTMF signal and sidetone beep are generated continuously (as long as the keypad button is held down) and for as long as the auto-push-to-talk timer in the microphone is active. The minimum time a keypad button must be held down depends on the decoder or telephone interconnect used at the receiving end of the system. Once the auto-push-to-talk timer times out, the radio transmitter dekeys, and continued attempts to generate the remaining DTMF signal tones are meaningless.

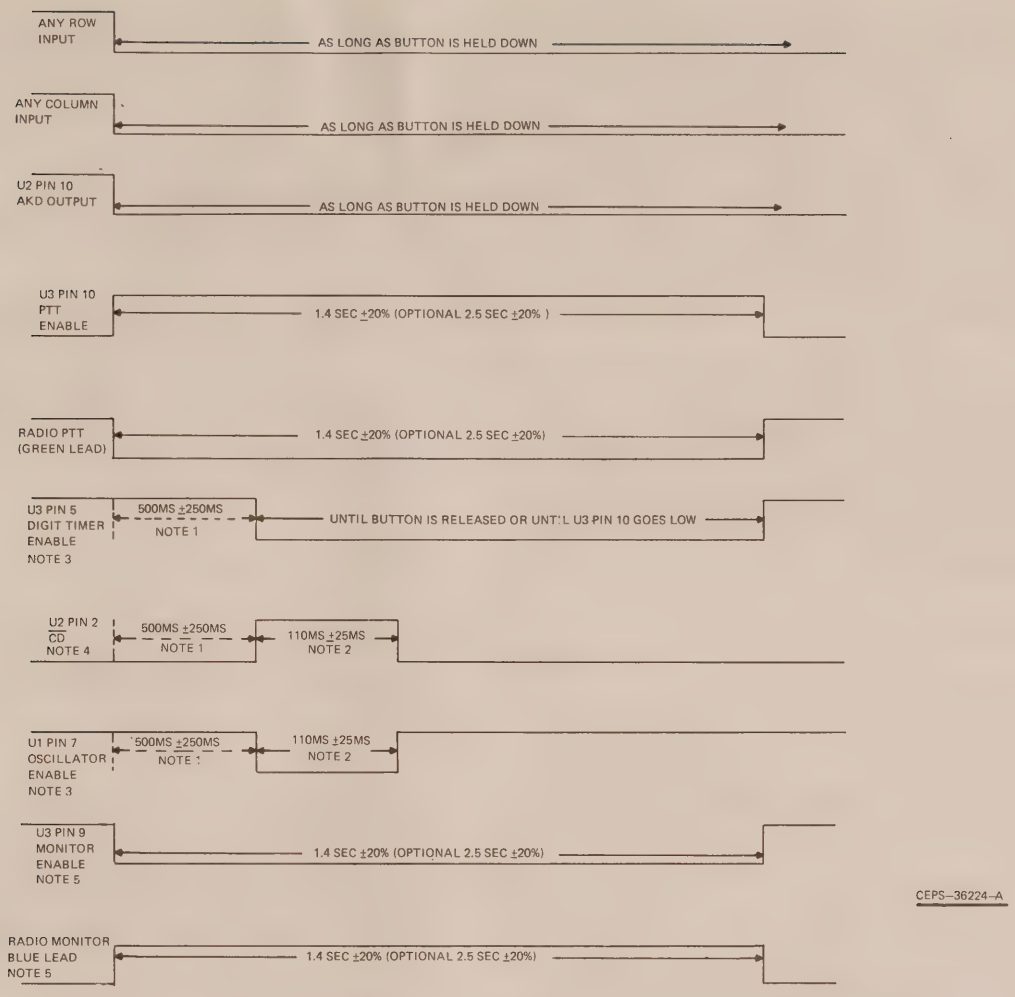
4. Detailed Circuit Description

Operating voltage for the microphone circuits is applied to the microphone from the MIC HI line, J4-1. In the *Touch-Code* mode, the microphone circuits disable, and the tone generating circuits receive operating voltage through PTT switch S1. See the Functional Block Diagram (Figure 1) and the appropriate schematic diagram at the back of this manual.

When a keypad entry is made, both the row and column inputs associated with that key are grounded. See the Timing Waveforms (Figure 2) and the logic board schematic at the back of this manual. The AKD line (U2 at Pin 10) goes low and triggers PTT timer U3 at Pin 11. Timer output (U3 at Pin 10) goes high (PTT ENABLE), and turns on transistors Q4 and Q5 (located on the microphone and beeper board). These devices, in turn, ground J4-5 and enable radio push-to-talk. The time duration of the PTT timer (U3B) is determined by R29, R30, C20, and JU4.

Tone Monitor line (U3 at Pin 9) goes low during auto-push-to-talk, and turns off Q3 through CR2 and CR3. This allows the Monitor line (J4-2) to go high, and puts the radio into the Monitor mode. This is required on radios that inhibit push-to-talk while not in a Monitor mode. Only radios with *Private-Line* or *Digital Private-Line* squelch (and with no external hang-up box) use this circuit.

The low on U2 at Pin 10 (AKD) is also applied to AKD Inverter U4D. The output of U4D at Pin 11 goes high, and is applied to the First Digit Delay gate U4C at Pin 8. The high on PTT timer U3 at Pin 10 is coupled to First Digit Delay gate U4C at Pin 9 through delay circuit R39 and C25. This causes a 500-millisecond delay before U4C at Pin 10 goes low. This delay occurs only if the auto-PTT function is not enabled at the time the keypad button is pressed. This 500-milliscond delay insures that an RF path is established before the DTMF signalling tones are generated.



NOTES:

1. If U3 Pin 10 is high when any button is pressed, the pulse starts at dashed line. If U3 Pin 10 is low, pulse follows solid line.
2. This pulse duration is 0.50 seconds ±20% when the* or # button is pressed. Pulse duration may be increased to 1.25 seconds ±20% by changing position of JU5. See schematic diagram for logic board HLN4522B.
3. This waveform applies to models using timed tone operation (JU3 in Position B).
4. *Touch-Code* tones are present on Mic Hi line (J4-1) anytime $\overline{CD}$ (U2-2) is high and any keypad button is pressed.
5. This waveform applies to models with *Private-Line* only.

Figure 2. Timing Waveforms for Timed-Tone Models

After the 500-millisecond delay occurs, the low on U4C at Pin 10 enables Digit Timer U3A at Pin 5. The timer output (U3A at Pin 6) goes high and enables U2 at Pin 2 ($\overline{CD}$). The digit timer duration for digits 0 to 9 is determined by R26 and C19. Gates U4A and U4B detect if the pressed key is a * or #. If a * or # key function is detected, U4 at Pins 3 and 4 go high, and turn off transistor Q7 through CR7, CR6, and R27. Turning off Q7 changes the digit timing on the * and # buttons by adding R37 or R38 (via jumper JU5) to timing resistor R26.

Note

When the continuous tone mode is selected (JU3 to Point A), AKD Inverter output (U4D at Pin 11) is routed to U2 at Pin 2 ($\overline{CD}$). This immediately enables tone output and does not make use of the Digit Timer or First Digit Delay circuits. The high transistion on U2 at Pin 2 ($\overline{CD}$) enables DTMF tone output from U2 at Pin 16. The tones pass through deviation potentiometer R32 and are then amplified by Q6. DTMF tones are next applied to the MIC HI line J4-1 via J3, P3-5, and through PTT Switch S1.

When DTMF tones are present on U2 at Pin 16, the dc level at this point shifts to 1.2 volts. This voltage shift turns on transistor Q2 (on the microphone and beeper board) through resistor R5, that in turn rounds U1 at Pin 7 and enables beeper oscillator U1A, U1B, and U1C. Beeper oscillator frequency is determined by R6, R7, R8, and C7. The oscillator ouput is buffered by U1D and amplified by Q8. The oscillator signal is then applied to piezo transducer Y1 to produce a 3450-Hz sidetone.

Pressing the PTT Switch S1 removes all power from the tone generator circuits and energizes microphone circuit Q1. The output of microphone cartridge M1 is amplified by Q1 and applied to the MIC HI line via PTT Switch S1. With the PTT switch pressed, radio PTT is grounded through the PTT switch to enable the radio transmitter.

5. Maintenance

5.1 INTRODUCTION

Use this section of the manual, the schematic diagrams, the troubleshooting guide, and deductive processes to help isolate and replace defective components.

Caution

Many of the integrated circuit devices used in this equipment are vulnerable to damage from static charges. Care must be taken in handling, shipping, and servicing these components and the assemblies of which they are a part.

5.2 *TOUCH-CODE* DEVIATION ADJUSTMENT

The *Touch-Code* feature of the microphone and radio has been adjusted at the factory for proper deviation. Readjustment may be required if either the radio transmitter or the microphone are serviced. The radio must be adjusted for proper Instantaneous Deviation Control (IDC) prior to checking *Touch-Code* deviation.

(1) Adjust a service monitor (Motorola Part No. R1200A or equivalent) to the radio transmitter frequency.

(2) Prior to checking *Touch-Code* deviation, disable all other sources of modulation such as *Private-Line, Digital Private-Line,* or Low-Speed Data.

(3) Press the # button on the keypad, and observe the *Touch-Code* deviation on the service monitor. Correct deviation is 3 kHz.

(4) An access hole for the tone deviation potentiometer (R32) is located on the rear housing to the right of the nameplate. A long tuning tool (Motorola Part No. 66-84974L01) is required.

(5) Adjust tone deviation potentiometer R32 for 3-kHz deviation of the DTMF signal (if required).

(6) When setting deviation, it is important to set the level during the 1.2 seconds immediately following actuation of the # button. This is necessary since accurate setting of deviation can only be achieved if the automatic push-to-talk feature is enabled when the deviation level is set.

5.3 JUMPER FUNCTIONS

JU1 may or may not be installed at the factory, depending on the type of radio with which the microphone is used.

To inhibit DTMF tone generation when two keypad buttons in the same row or column are pressed, JU2 is removed. With JU2 installed, pressing two keypad buttons in the same row or column generates a single DTMF tone for that row or column.

If JU3 is installed in Position A, continuous tone mode is selected. If JU3 is installed in Position B, timed tone mode is selected.

If JU4 is installed in Position C, the auto-PTT hold time is 1.4 seconds (or 2.5 seconds if JU4 is installed in Position D).

If JU5 is installed in Position F, the *, # time duration is 0.5 second (or 1.25 seconds if JU5 is installed in Position G).

5.4 TROUBLESHOOTING
(See Table 1.)

The *Touch-Code* Microphone Troubleshooting Guide lists possible trouble indications and solutions. To use the table, locate the indicated trouble in the left-hand column. Beside each trouble indication is a number of possible problem areas that are listed in order of most probable to least likely. Simply perform the steps in numerical sequence. By using the information and procedures provided, faulty circuitry may be rapidly located and repaired.

Table 1. Touch-Code *Microphone Troubleshooting Guide*

TROUBLE INDICATION	POSSIBLE PROBLEM AREA
No DTMF Tones	1. Verify power applied at: J4-1, 5.6V; collector of Q6, 5.6V; and emitter of Q6, 4.6V. Locate area of defective power distribution.
	2. Verify AKD output at U2 Pin 10. Output should be 3.7V when no button is pressed, and less than 0.5V when any keypad button is pressed.
	3. Verify that only one row input (U2 Pin 11, 12, 13, or 14) and one column input (U2 Pin 3, 4, or 5) are pulled low by the keyboard for each button pressed. (For example, Pins 3 and 14 go low when "1" is pressed.)
	4. Check for proper placement of C16-Y2 pair, and for any solder shorts, etc. No U2 output results if oscillator does not run.
	5. If Step 3 checks okay, and Step 2 does not, U2 or C16-Y2 is defective. If Step 3 does not check okay, keyboard or connectors may be defective.
	6. Verify that U2 at Pin 2 receives a pulse when any keypad button is pressed. The pulse on U2 at Pin 2 must be high to generate tones. See timing diagram for pulse duration. If no pulse, see the digit timer malfunction in this table.
	7. Check for DTMF tones on U2 at Pin 16. If no tones, and Steps 2 through 6 are okay, then U2 or C16-Y2 is defective.
	8. Check for DTMF tones on base and collector of Q6. If no tones, check tone amplifier circuitry for defective components, shorts, etc.
Digit Timing Malfunction	1. Verify proper operation of auto-PTT timer.
	2. Check Steps 1 through 5 under "No DTMF Tones."
	3. Verify that U4 at Pin 11 and Pin 8 go high when any keypad button is pressed. If Pins 11 and 8 are not high, check for 4.6 volts at U4 Pin 14; check U4 solder connections.
	4. Check that U4 at Pin 9 goes high approximately 500 msec. after U3 at Pin 10 goes high. If U4 at Pin 9 does not go high, check R39, C25, and solder connections.
	5. Verify that U3 at Pin 5 goes low when any keypad button is pressed, and U3 at Pin 10 is high. If U3 at Pin 5 does not go low, check U4 solder connections.
	6. Check U3 at Pin 6 for 110 msec. pulse (high) when 0 through 9 keypad button is pressed. If no pulse, check R26 and C19 connections. Check that collector of Q7 is at 4.6V. If not, check timing of *, # buttons. If timing of *, # buttons are incorrect, proceed with following trouble indication.
*, # Button Timing Incorrect	1. Verify that U4 at Pins 1, 2, 5, and 6 are high with no keypad buttons pressed. If not, check keypad assembly for short between pins.
	2. Verify that U4 at Pins 3 and 4 go high when either * or # keypad button is pressed. If not, check for 4.6 volts at U4 Pin 14; check U4 solder connections.
	3. Measure directly across base-emitter of Q7 for zero volts when * or # keypad button is pressed. (Base-emitter of Q7 should measure 0.6 volts with no keypad button pressed.)
	4. Check R37 and R38 for opens or shorts. Check JU5.
Auto-PTT Malfunction	1. Verify that U3 at Pin 11 goes low when any keypad button is pressed. If not, see the "No DTMF Tones" section in this table.
	2. Check that U3 at Pin 10 goes high for 1.4 to 2.5 seconds (depending on Position of JU4). If not, check R29, R30, C20, and JU4. Check for good solder connections on U3.
	3. Verify that Q4 base goes to 1.4V when U3 at Pin 10 goes high. If not, check J3/P3 connection and R14.
	4. Check that collector of Q5 goes low when Q4 base goes to 1.4V. If not, verify proper use of JU1 and R18 (see notes on schematic for microphone and beeper board).
No Sidetone	1. Press any keypad button and verify that DTMF tones are present on U2 at Pin 16. If not, see the "No DTMF Tones" in this table.
	2. Check that U2 at Pin 16 goes to 1.2 volts during digit timer pulse.
	3. Verify that Q2 base goes to 0.6V during digit timer pulse. If not, check P3/J3 connector and R5.
	4. Verify that U1 at Pin 7 goes low during digit timer pulse. If not, check Q2 and solder connections of U1.
	5. Check waveform at C14 as shown on microphone and beeper board schematic. If no waveform, check R6, R7, R8, C7, and U1 solder connections.
	6. Check waveform on collector of Q8. If no waveform, check Q8, L1, and R11.
	7. If Steps 2 through 6 are okay, Y1 is defective.
No Microphone Audio, but DTMF Tones are Transmitted	1. Check for 3.5V to 5.5V on collector of Q1 with microphone PTT button pressed.
	2. Check Q1 base and emitter voltages per schematic diagram.
	3. Check for poor solder connections, shorts, etc.
Monitor Switch Malfunction *Private-Line* Models Only)	1. Verify proper operation of auto-PTT timer.
	2. Check that U3 at Pin 9 goes low for 1.4 to 2.5 seconds (depending on position of JU4).
	3. Check that base of Q3 is 0.7V in standby mode and 0.2V when auto-PTT is enabled. If not, check J3/P3 connector, CR2, CR3, and R10 for opens or shorts.
	4. With microphone in hangup box, check collector of Q3 for low in standby mode and high when auto-PTT is enabled. This collector voltage is supplied by the radio.

Table 1. Touch-Code *Microphone Troubleshooting Guide (Continued)*

TROUBLE INDICATION	POSSIBLE PROBLEM AREA
Some Buttons Work, Others Do Not	1. Try to determine if problem is row or column related.
	2. Check corresponding pin at U2 for defective row or column. See Step 3 under "No DTMF Tones" in this table.
	3. Most likely problem areas are shorts between pins on keypad assembly, or keyboard printed circuit foil runners are defective.
	4. U2 may produce a single tone or no tones if more than one row or column input is grounded.
Tones Off Frequency	1. Y2-C16 defective.
	2. Foreign material or solder short in Y2-C16 or U2 area.
	3. U2 defective (not likely).

MOTOROLA

IMPORTANT

TOUCH-CODE™ ENCODER MICROPHONE OPERATION INFORMATION FOR THE MOBILE RADIO OPERATOR. RADIO INSTALLER: PLEASE LEAVE THIS CARD WITH MICROPHONE.

GENERAL INFORMATION

The *Touch-Code* encoder microphone allows the transmission of standard *Touch-Code* dual-tone multi-frequency (DTMF) signals which are used for remote signaling applications and mobile telephone operations. The DTMF tone transmissions are pre-timed to allow enough time to access most systems. If continuous tone operation is desired, the microphone can be adapted. See the Microphone Service Manual 68P81114E07 for details.

RADIO OPERATION

The *Touch-Code* microphone can operate with numerous radio sets in a variety of applications such as trunking systems, telephone interconnect, data access, etc. Consult the radio set operator's manual or telephone interconnect manual for instructions on use of the *Touch-Code* encoder microphone in your system.

TWO-WAY RADIO OPERATION

- Hold the microphone approximately two inches from the lips.
- Press the push-to-talk button.
- Speak directly into the small opening in the key pad.
- Release the push-to-talk button to listen.

TOUCH-CODE MICROPHONE OPERATION FOR MODELS USED IN TRUNKED RADIO SYSTEMS ONLY

- Enter the digits desired through the key pad by firmly depressing a finger for one key pad button at a time.
- Hold each button down until you hear the tone stop.
- Failure to hold the button down until the tone stops may cause a misdialed number.
- Do not press the push-to-talk button. Simply depressing a number button on the key pad activates the automatic push-to-talk feature. This feature remains enabled while a key pad button is pressed.
- After all digits have been entered, the microphone operates in the normal two-way radio operation mode.

PLEASE REFER TO THE OTHER SIDE OF THIS CARD.

68P81114E13-C
11/5/83-

TOUCH-CODE MICROPHONE OPERATION FOR MODELS USED IN ALL NON-TRUNKED RADIO SYSTEMS

- Enter the digits desired through the key pad by firmly pressing a finger on one key pad button at a time.
- A tone is heard as each key pad button is pressed.
- The minimum length of time a key pad button should be pressed is 1/2 second. This is necessary to overcome radio system delays and prevent misdialed numbers.
- The maximum length of time a key pad button can be pressed is 1.2 seconds. At this time, the automatic push-to-talk feature completes its cycle and the transmitter dekeys.
- Do not press the push-to-talk button. Simply depressing a number button on the key pad activates the automatic push-to-talk feature. This feature remains enabled while a key pad button is pressed, to the maximum time of 1.2 seconds.
- After all digits have been entered, the microphone operates in the normal two-way radio operation mode.

IMPORTANT

The *Touch-Code* microphone is designed to work with specific Motorola products. Different *Touch Code* microphone models may look identical but cannot be interchanged between different Motorola radio sets. Refer to the model number on the back of the microphone and the microphone service manual to determine compatability between *Touch Code* microphone models and different Motorola radio sets.

Model HMN1023A Microphone, used with MCX100 radios equipped with ChannelScan™, must be removed from the hang-up clip to ensure proper operation when the scanner is enabled.

TIPS FOR USING YOUR *TOUCH-CODE* ENCODER MICROPHONE

DTMF signaling was originally developed for telephone signaling on phone lines, and certain simple precautions can significantly enhance its reliability when used in a mobile radio environment. Timing and tone frequencies are fixed by the Public Switched Telephone Network placing some constraints on its adaptability to a mobile radio. Therefore, the following suggestions are offered for your use:

1. Limit placing your calls *whenever possible* to areas of optimum systems coverage (full quieting). Calls made in noisy (fringe) areas may not go through.
2. Whenever possible, initiate your calls when the vehicle is not moving, i.e. parked or at a stop sign or light. Dialing while driving can distract the driver (a safety hazard) and reduce the reliability of the signaling due to weak signal (dead spots) or noise interference encountered with 2-way radios while in a moving vehicle.

parts list

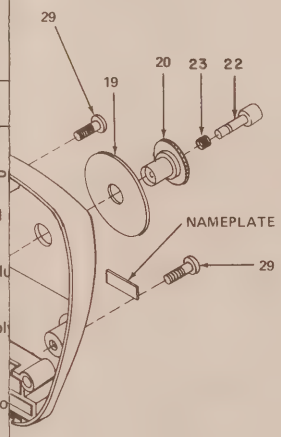
HLN4530A Keypad

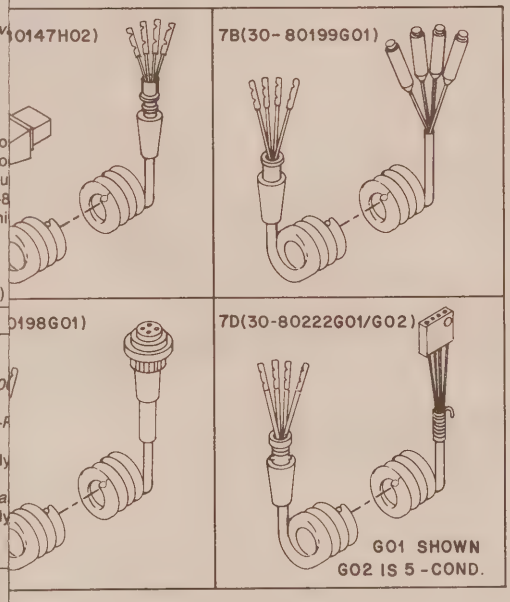
REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		connector
5	28-80085E09	male header, P1 and P2
		mechanical parts
3	07-80188F02	keypad frame
4	45-80192F01	keypad actuator
6	84-80189F01	PC board keypad

note: See the mechanical exploded view of microphone for further infor
is not field-repairable, and must be ordered as a complete kit.

Mechanical Parts for Microphone Hardware Kits

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
1	15-80185F01	front microphone housing
2.	38-80144D03	microphone PTT button
3–6	—	keypad assembly parts (see P
6A	—	logic board (see PL-8437)
7	—	microphone cable (see Model
8	42-80188G01	O-ring retainer
9	43-80187F01	PC board spacer
10	01-80725T32	transducer assembly (Y1) inclu
	50-80289G01	transducer
	58-80288G01	adapter
	01-80725T82	microphone cartridge assembl
11	32-80119G01	gasket
12	43-80006G02	spacer
12A	50-80258E09	electret condenser
13	—	S2 switch, *Private-Line* units o MXW-2778)
14	40-80252E02	contact button, *Private-Line* un
15	—	S1 switch, momentary (see MX
16	—	P3 connector (see MXW-2778)
17	—	microphone and beeper board
	01-80730T23	rear microphone housing, non- units only
	01-80730T59	rear microphone housing, *Priv* only
18	15-80186F02	rear housing
19	04-80093E01	flat washer
20	46-80086E06	microphone hangup stud
21	46-80281G01	weight
22	45-80113D02	plunger, *Private-Line* units o
23	41-80096E02	plunger, *Private-Line* units o
24	42-80166E01	retaining ring, *Private-Line* u
25	—	J1 and J2 connector (see PL-8
26	32-80253E02	switch gasket, *Private-Line* uni
27	—	J3 connector (see PL-8437)
28	03-80076E07	metric screw, 3 used
29	03-80076E05	metric screw, 4 used
30	—	J4 connector (see MXW-2778)
		non-referenced items
	14-84360C01	switch insulator
	35-80089D02	felt baffle
	42-83894F02	microphone cord clip, *MCX-10* only
	01-80738T96	microphone hangup clip, non-*P* only
	01-80707T05	spring and bracket assembly
	03-00139913	tapping screw (#8-18 × ½)
	01-80743T05	microphone hangup clip, *Priva*
	01-80707T05	spring and bracket assembly
	03-00138015	tapping screw (#8-18 × ½)
	03-00140035	tapping screw (#6-20 × ½)





Exploded View and Mechanical Parts Lists for
DTMF *Touch-Code* Encoder Microphone
PEPS-36480-B
3/20/86

TOUCH-CODE MICROPHONE OPERATION FOR MODELS USED IN ALL NON-TRUNKED RADIO SYSTEMS

- Enter the digits desired through the key pad by firmly pressing a finger on one key pad button at a time.
- A tone is heard as each key pad button is pressed.
- The minimum length of time a key pad button should be pressed is 1/2 second. This is necessary to overcome radio system delays and prevent misdialed numbers.
- The maximum length of time a key pad button can be pressed is 1.2 seconds. At this time, the automatic push-to talk feature completes its cycle and the transmitter dekeys.
- Do not press the push-to-talk button. Simply depressing a number button on the key pad activates the automatic push-to talk feature. This feature remains enabled while a key pad button is pressed, to the maximum time of 1.2 seconds.
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IMPORTANT

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2. Whenever possible, initiate your calls when the vehicle is not moving, i.e. parked or at a stop sign or light. Dialing while driving can distract the driver (a safety hazard) and reduce the reliability of the signaling due to weak signal (dead spots) or noise interference encountered with 2-way radios while in a moving vehicle.

parts list

HLN4530A Keypad — PL-8439-B

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		connector
5	28-80085E09	male header, P1 and P2
		mechanical parts
3	07-80188F02	keypad frame
4	45-80192F01	keypad actuator
6	84-80189F01	PC board keypad

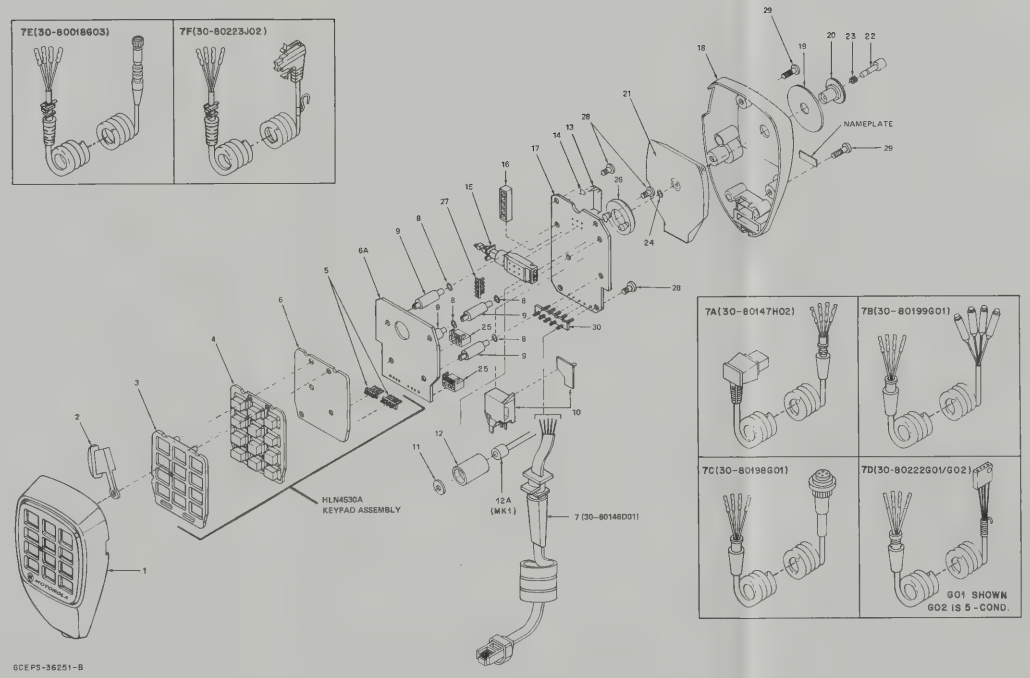
3/24/86

note: See the mechanical exploded view of microphone for further information. This item is not field-repairable, and must be ordered as a complete kit

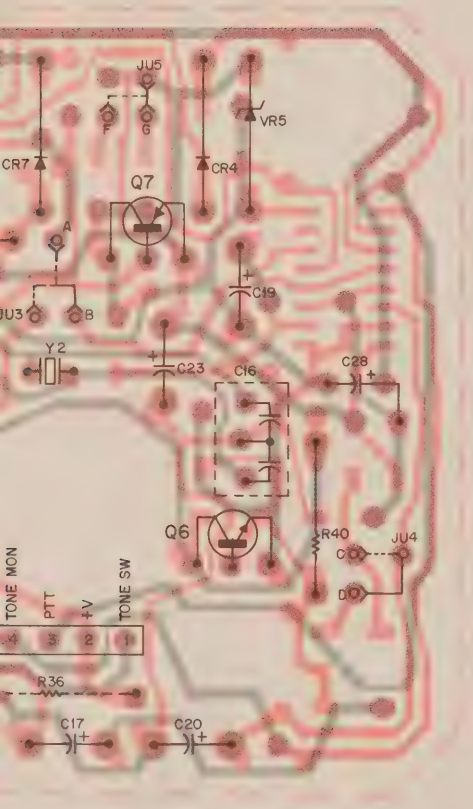
Mechanical Parts for Microphone Hardware Kits — MXW-2777-O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
1	15-80185F01	front microphone housing
2	38-80144D03	microphone PTT button
3–6	—	keypad assembly parts (see PL-8439)
6A	—	logic board (see PL-8437)
7	—	microphone cable (see Model Chart)
8	42-80188G01	O-ring retainer
9	43-80187F01	PC board spacer
10	01-80725T32	transducer assembly (Y1) includes:
	50-80289G01	transducer
	58-80288G01	adapter
	01-80725T82	microphone cartridge assembly includes:
11	32-80119G01	gasket
12	43-80006G02	spacer
12A	50-80258E09	electret condenser
13	—	S2 switch, *Private-Line* units only (see MXW-2778)
14	40-80252E02	contact button, *Private-Line* units only
15	—	S1 switch, momentary (see MXW-2778)
16	—	P3 connector (see MXW-2778)
17	—	microphone and beeper board (see MXW-2778)
	01-80730T23	rear microphone housing, non-*Private-Line* units only
	01-80730T59	rear microphone housing, *Private-Line* units only
18	15-80186F02	rear housing
19	04-80093E01	flat washer
20	46-80086E06	microphone hangup stud
21	46-80281G01	weight
22	45-80113D02	plunger, *Private-Line* units only
23	41-80096E02	plunger, *Private-Line* units only
24	42-80166E01	retaining ring, *Private-Line* units only
25	—	J1 and J2 connector (see PL-8437)
26	32-80253E02	switch gasket, *Private-Line* units only
27	—	J3 connector (see PL-8437)
28	03-80076E07	metric screw, 3 used
29	03-80076E05	metric screw, 4 used
30	—	J4 connector (see MXW-2778)
		non-referenced items
	14-84360C01	switch insulator
	35-80089D02	felt baffle
	42-83894F02	microphone cord clip, *MCX-100* remote units only
	01-80738T96	microphone hangup clip, non-*Private-Line* units only
	01-80707T05	spring and bracket assembly
	03-00139913	tapping screw (#8-18 × ½)
	01-80743T05	microphone hangup clip, *Private-Line* units only
	01-80707T05	spring and bracket assembly
	03-00138015	tapping screw (#8-18 × ½)
	03-00140035	tapping screw (#6-20 × ½)

3/24/86



Exploded View and Mechanical Parts Lists for
DTMF *Touch-Code* Encoder Microphone
PEPS-36480-B
3/20/86



TRANSISTOR DETAIL
TOP VIEW
C B E
Q6 - M8208
Q7 - M8209

COMPONENT SIDE BD-CEPS-36213-O
SOLDER SIDE BD-CEPS-36214-O
OL-CEPS-36215-B

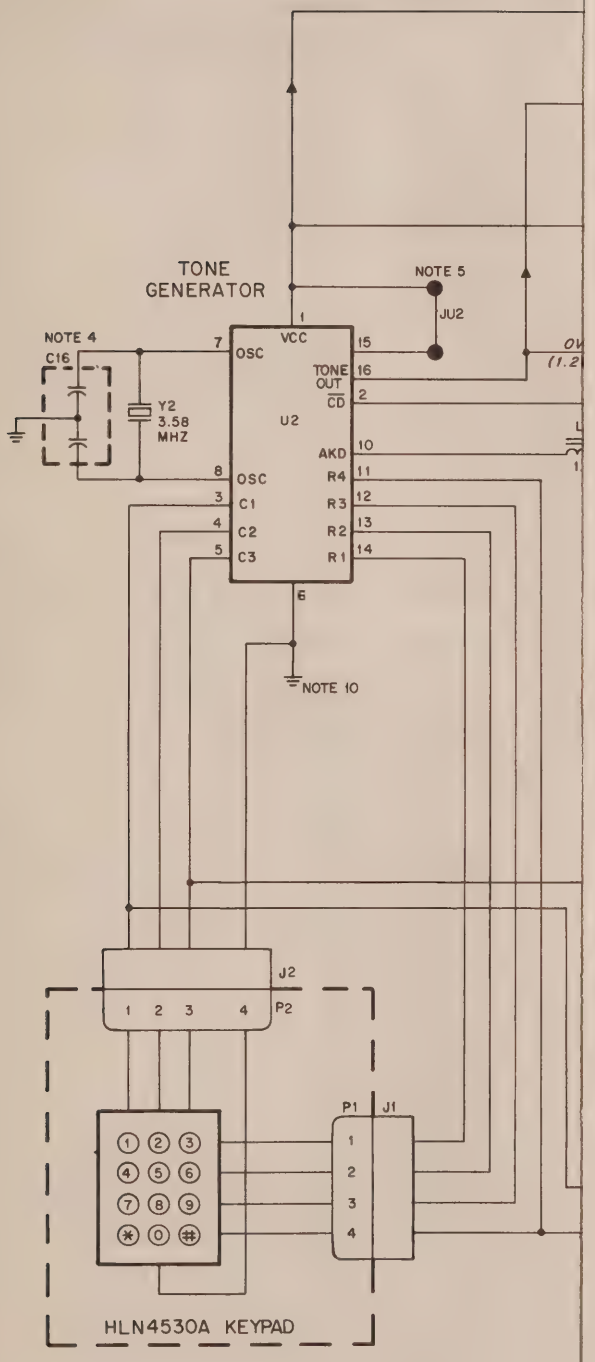
parts list

HLN4522B Tone and Logic Board PL-8437-B

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		capacitor, fixed, μF ±10%, 50V unless otherwise stated
C17	23-11013F57	1 ±20%, 35V, tantalum
C18	21-11032A21	.01
C19, 20	23-11013D05	2.2, 20V, tantalum
C21, 22	21-11032A09	.001
C23	23-11013D15	15, 20V, tantalum
C24	21-11032A09	.001
C25	23-11013D05	2.2, 20V, tantalum
C26, 27	21-11032A09	.001
C28	23-11013F57	1 ±20%, 35V, tantalum
		diode (see note)
CR4, 6, 7	48-83654H01	silicon
		connector plug
J1, 2	09-80238F01	4-pin
		coil
L2	24-82723H27	1.2 μH
		connector receptacle
P3	28-80085E08	male header connector
		transistor (see note)
Q6	48-80182D08	NPN, type M82D08
Q7	48-80182D09	PNP, type M82D09
		resistor, fixed, Ω ±5%, ⅛ W unless otherwise stated
R25	06-11024A97	100k
R26	06-11024A89	47k
R27	06-11024A97	100k
R28	06-11024B02	150k
R29	06-11024B14	470k
R30	06-11024B16	560k
R32	18-80261F01	10k ±10%, ½ W
R33	06-11024A63	3.9k
R37	06-11024B15	510k
R38	06-11024B04	10k
R39	06-11024B08	270k
R40	06-11009A65	4.7k, ¼ W
R41	06-11024B20	820k
		integrated circuit (see note)
U2	51-80065C11	tone generator
U3	51-80073C09	dual monostable
U4	51-80073C08	quad nand gate
		varactor
VR5	48-80007E08	4.7V zener
		crystal (see note)
Y2	48-80173D03	ceramic resonator

3/24/86

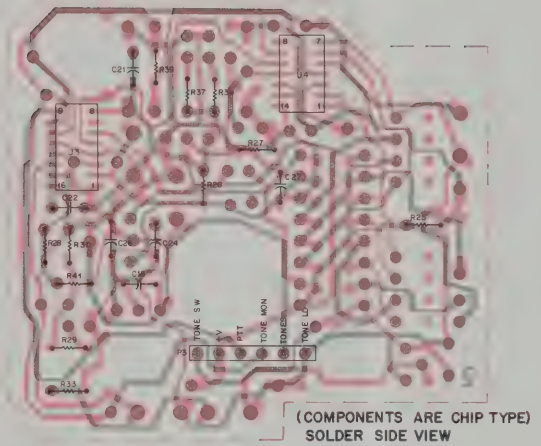
note: For best performance, order diodes, transistors, and integrated circuits by Motorola part number.



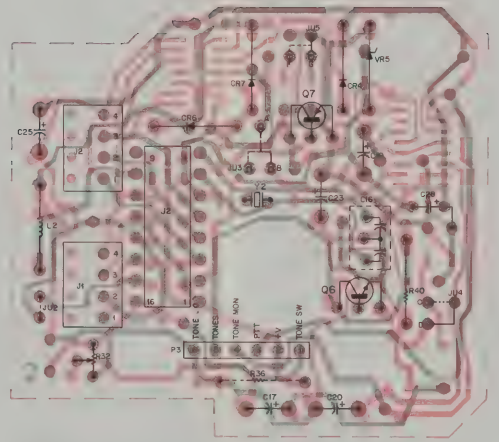
NOTES:

1. Placing JU3 in Position A defeats timed tone operation. In Position A, tone duration lasts as long as touch-pad key is pressed. In Position B, tone duration is controlled by timer U3.
2. Placing JU4 in Position C selects a PTT hold time of 1.4 seconds. Placing JU4 in Position D selects a PTT hold time of 2.5 seconds.
3. Placing JU5 in Position F selects a *, # time of .5 second. Placing JU5 in Position G selects a *, # time of 1.25 seconds.
4. Y2 and C16 are a matched set and must be replaced as a pair. See parts list.
5. Pressing two keypad buttons in the same row or column will generate the single tone for that row or column. Removing jumper JU2 will inhibit any tone generation if more than one keypad button is pressed.
6. Voltages indicated as (0.1V) are active voltages (when either PTT or keypad buttons are depressed). Standby voltages are shown without parenthesis.
8. J3 connects to P3 on HLN4523B and to HLN4775A Mic and Beeper Board (when used).
9. Unless otherwise indicated, resistor values are in ohms, and capacitor values are in microfarads.
10. The ground symbol on this diagram is actually referenced to mic lo, not radio set ground.

Schematic, Circuit Board Diagrams, and
Parts List for HLN4522B
Tone and Logic Board
PEPS-36481-B
(Sheet 2 of 2)
3/20/86



COMPONENT SIDE ◎ BD-CEPS-36213-O (REVERSED)
SOLDER SIDE ◎ BD-CEPS-36214-O (REVERSED)
OL-CEPS-36216-B



COMPONENT SIDE ◎ BD-CEPS-36213-O
SOLDER SIDE ◎ BD-CEPS-36214-O
OL-CEPS-36215-B

parts list

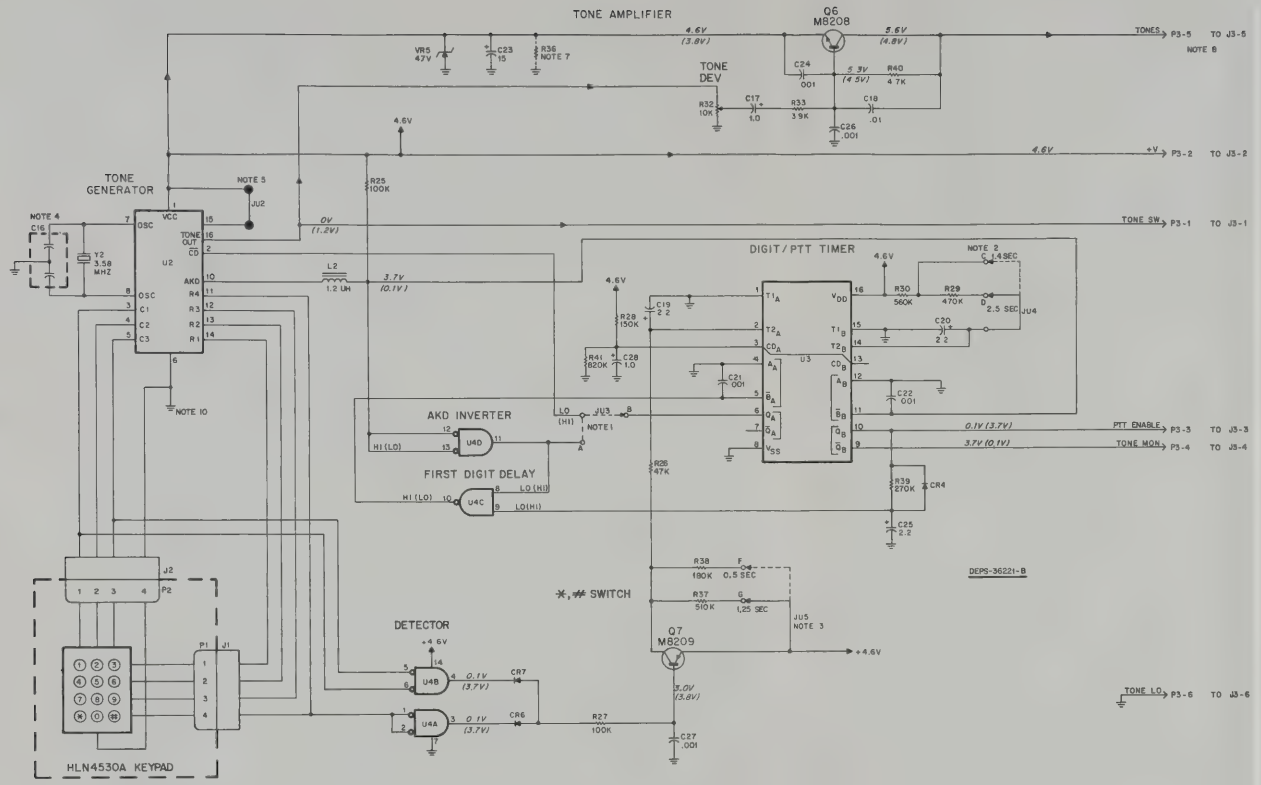
HLN4522B Tone and Logic Board — PL-8437-B

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		capacitor, fixed, μF ±10%, 50V unless otherwise stated
C17	23-11013F57	1 ±20%, 35V, tantalum
C18	21-11032A21	.01
C19, 20	23-11013D05	2.2, 20V, tantalum
C21, 22	21-11032A09	.001
C23	23-11013D15	15, 20V, tantalum
C24	21-11032A09	.001
C25	23-11013D05	2.2, 20V, tantalum
C26, 27	21-11032A09	.001
C28	23-11013F57	1 ±20%, 35V, tantalum
		diode (see note)
CR4, 6, 7	48-83654H01	silicon
		connector plug
J1, 2	09-80238F01	4-pin
		coil
L2	24-82723H27	1.2 μH
		connector receptacle
P3	28-80085E08	male header connector
		transistor (see note)
Q6	48-80182D08	NPN, type M82D08
Q7	48-80182D09	PNP, type M82D09
		resistor, fixed, Ω ±5%, ⅛ W unless otherwise stated
R25	06-11024A97	100k
R26	06-11024A89	47k
R27	06-11024A97	100k
R28	06-11024B02	150k
R29	06-11024B14	470k
R30	06-11024B16	560k
R32	18-80261F01	10k ±10%, ½ W
R33	06-11024A83	3.9k
R37	06-11024B15	510k
R38	06-11024B04	10k
R39	06-11024B06	270k
R40	06-11009A85	4.7k, ¼ W
R41	06-11024B20	820k
		integrated circuit (see note)
U2	51-80065C11	tone generator
U3	51-80073C09	dual monostable
U4	51-80073C08	quad nand gate
		varactor
VR5	48-80007E08	4.7V zener
		crystal (see note)
Y2	48-80173D03	ceramic resonator

3/24/86

note: For best performance, order diodes, transistors, and integrated circuits by Motorola part number.

Schematic, Circuit Board Diagrams, and
Parts List for HLN4522B
Tone and Logic Board
PEPS-36481-B
(Sheet 1 of 2)
3/20/86



NOTES:

1. Placing JU3 in Position A defeats timed tone operation. In Position A, tone duration lasts as long as touch-pad key is pressed. In Position B, tone duration is controlled by timer U3.
2. Placing JU4 in Position C selects a PTT hold time of 1.4 seconds. Placing JU4 in Position D selects a PTT hold time of 2.5 seconds.
3. Placing JU5 in Position F selects a *, # time of .5 second. Placing JU5 in Position G selects a *, # time of 1.25 seconds.
4. Y2 and C16 are a matched set and must be replaced as a pair. See parts list
5. Pressing two keypad buttons in the same row or column will generate the single tone for that row or column. Removing jumper JU2 will inhibit any tone generation if more than one keypad button is pressed
6. Voltages indicated as (0.1V) are active voltages (when either PTT or keypad buttons are depressed) Standby voltages are shown without parenthesis
8. J3 connects to P3 on HLN4523B and to HLN4775A Mic and Beeper Board (when used).
9. Unless otherwise indicated, resistor values are in ohms, and capacitor values are in microfarads.
10. The ground symbol on this diagram is actually referenced to mic lo, not radio set ground

Schematic, Circuit Board Diagrams, and
Parts List for HLN4522B
Tone and Logic Board
PEPS-36481-B
(Sheet 2 of 2)
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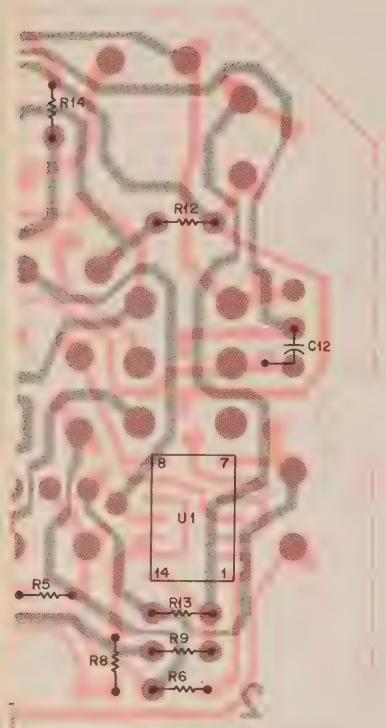
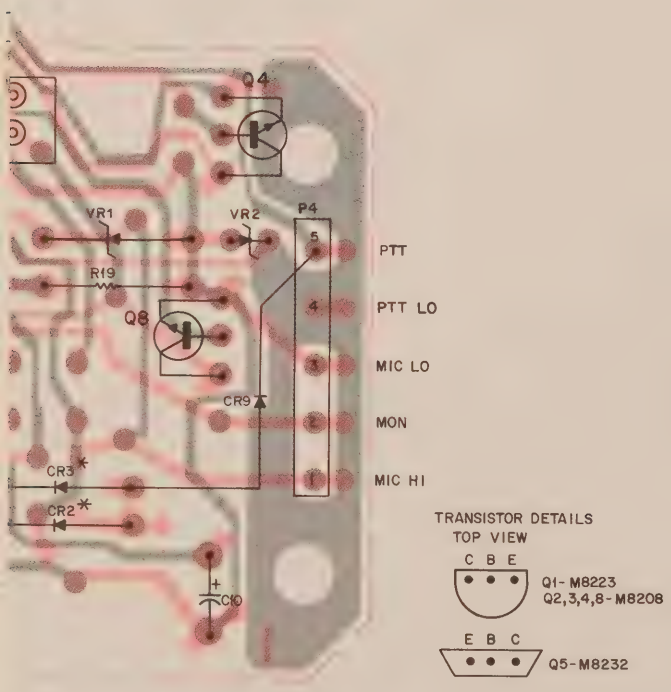


* S2 USED ON MCX100 MODELS ONLY

(REVERSED)
(REVERSED)



NOTE: COMPONENTS SHOWN WITH *, USED ON MCX100 MODELS ONLY.

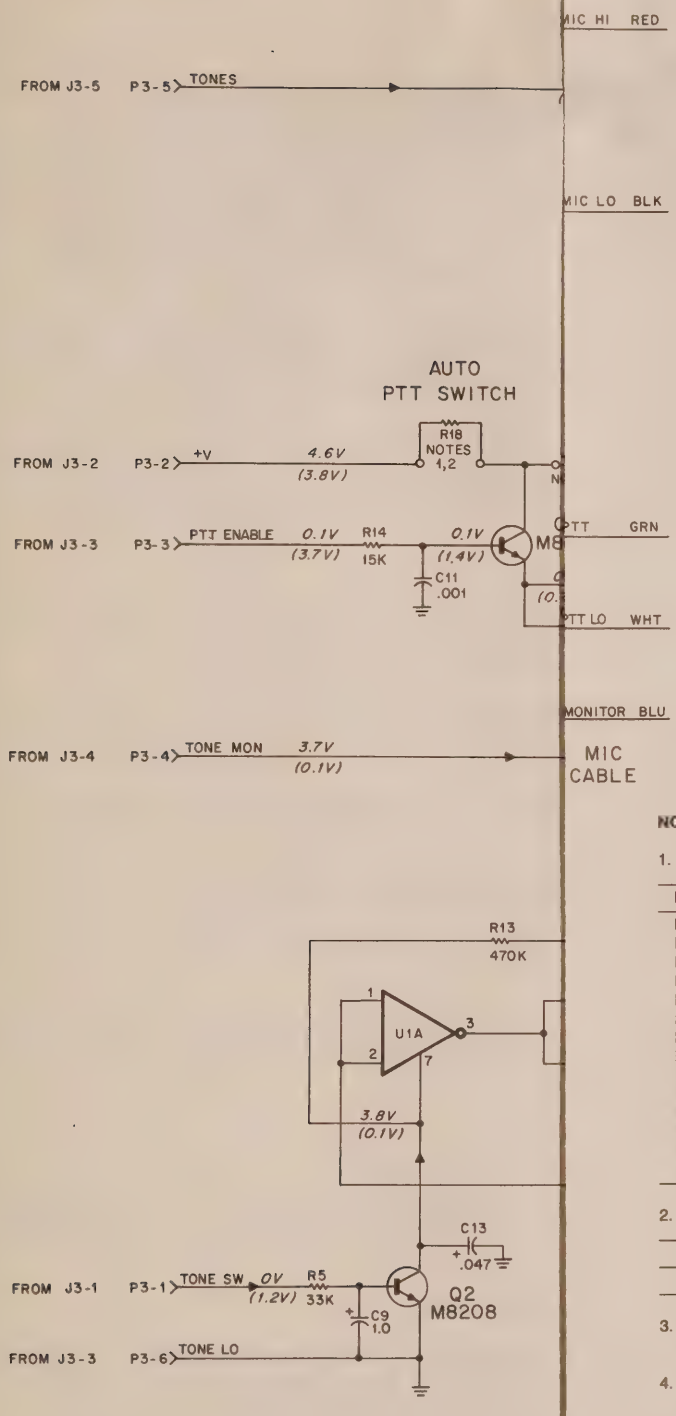
parts list

HLN4523B Microphone and Beeper Board
HLN4775A Microphone and Beeper Board MXW-2778-O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		capacitor, fixed, μF ±10%, 50V unless otherwise stated
C1	21-11032A09	.001
C2	08-11051A07	.01 ±5%, 63V
C3	21-11031A47	220 pF ±5%, 50V
C4	23-11013D13	10, 20V, tantalum
C5	21-11032A09	.001
C6	21-11031A25	27 pF ±5%
C7	08-11051A05	.0047 ±5%, 63V
C8	23-11013D13	10, 20V, tantalum
C9	23-11013F57	1 ±20%, 35V, tantalum
C10	23-11013C12	27, 15V, tantalum
C11	21-11032A09	.001
C12	21-11032A21	.01
C13	08-11051A11	.047 ±5%, 63V
C14	23-11013F57	1 ±20%, 35V, tantalum
		diode (see note)
CR2, 3	48-83654H01	silicon
CR9	48-83654H01	silicon (HLN1123B only—see tables on schematic)
		connector plug
J3	09-80237F01	6-pin
		jumper
JU1	06-11009F23	resistor (see tables on schematic)
		coil
L1	24-80108G02	audio 110 mH
		connector receptacle
P4	28-80085E03	male header
		transistor (see note)
Q1	48-80182D23	NPN, type M82D23
Q2–4	48-80182D08	NPN, type M82D08
Q5	48-80182D32	NPN, type M82D32
Q8	48-80182D08	NPN, type M82D08
		resistor, fixed, Ω ±5%, ⅛ W unless otherwise stated
R1	06-11009E19	56, ¼ W
R2	06-11024B10	330k
R3	06-11024A49	1k
R4	06-11024A57	2.2k (HLN4523B only—see tables on schematic)
	or 06-11024A61	3.3k (HLN4775A only—see tables on schematic)
R5	06-11024A85	33k
R6	06-11024A77	15k
R7	06-11024A51	1.2k
R8	06-11024A83	27k
R9	06-11024A33	220
R10	06-11024A85	33k
R11	06-11024A61	3.3k
R12	06-11024A77	15k
R13	06-11024B14	470k
R14	06-11024A77	15k
R18	06-11009E46	750, ¼ W (HLN4523B only—see tables on schematic)
	or 06-11009E53	1.5k, ¼ W (HLN4775A only—see tables on schematic)
	or 06-11009A71	8.2k, ¼ W (HMN1014B only—see tables on schematic)
R19	06-11009B08	270k, ¼ W (see tables on schematic)
		switch
S1	40-80065E02	momentary pushbutton
S2	40-80252E01	contact switch (*MCX-100* models only)
		integrated circuit (see note)
U1	51-80073C08	quad nand gate
		voltage regulator (see note)
VR1, 2	48-80007E07	12V zener

3/24/86

note: For best performance, order diodes, transistors, and integrated circuits by Motorola part number.



NOTES:

1. HLN4523B Microphone and Beeper Board Resistor, Diode, and Jumper Table.

MODEL	R18	R19	JU1	CR9
HMN1010B	OUT	IN	IN	OUT
HMN1011B	750 Ω	OUT	OUT	IN
HMN1014B	8.2k	IN	OUT	OUT
HMN1018B	750 Ω	OUT	OUT	OUT
HMN1019B				
HMN1020B	750 Ω	OUT	OUT	OUT
HMN1021B	750 Ω	OUT	OUT	OUT
HMN1022B	OUT	IN	IN	OUT
HMN1023B	750 Ω	OUT	OUT	IN
HMN1024B	750 Ω	OUT	OUT	IN
HMN1025B				
HMN1032A	OUT	IN	IN	OUT
HMN1033A	750 Ω	OUT	OUT	IN
HMN1034A	750 Ω	OUT	OUT	IN

2. HLN4775A Microphone and Beeper Board Resistor, Diode, and Jumper Table.

MODEL	R19	R18	JU1	R4	CR9
HMN1026B	OUT	1.5k	OUT	IN	OUT

3. Monitor switch circuitry in dashed box is operation for Models HMN1023B, HMN1024B, HMN1026B, HMN1032A, and HMN1033A only.

4. Voltages indicated in (0.2V) are active voltages (when either PTT or keypad buttons are pressed). Standby voltages are shown without parenthesis.

5. Unless otherwise indicated, resistor values are in ohms, and capacitor values are in microfarads.

6. JU6 is not used.

7. The ground symbol on this diagram is actually referenced to microphone low, not to radio ground.

Schematic, Circuit Board Diagrams, and Parts List for HLN4523B and HLN4775A Microphone and Beeper Boards

PEPS-36482-B

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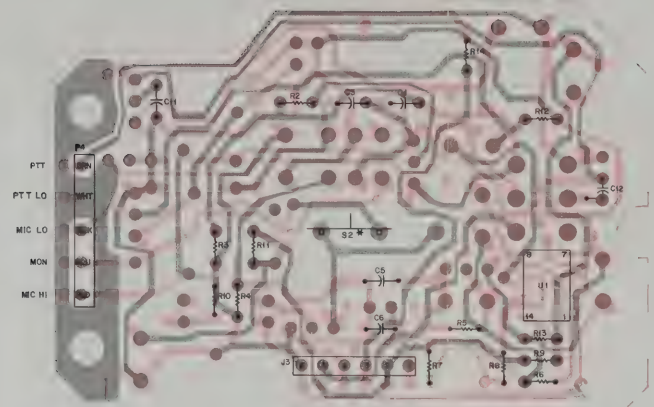
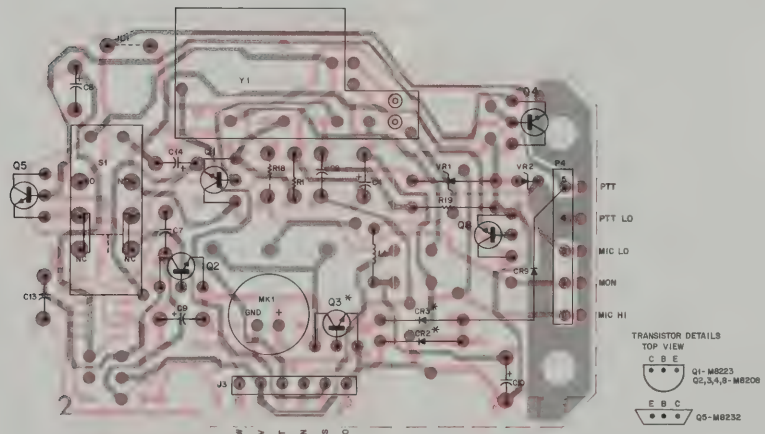


(COMPONENTS ARE CHIP TYPE)
SOLDER SIDE VIEW

* S2 USED ON MCX100 MODELS ONLY

COMPONENT SIDE ● BD-CEPS-36217-0 (REVERSED)
SOLDER SIDE BD-CEPS-36218-0 (REVERSED)
OL-CEPS-36220-B



TRANSISTOR DETAILS
TOP VIEW
C B E
Q1- M8223
Q2,3,4,8- M8208
E B C
Q5- M8232

COMPONENT SIDE

NOTE: COMPONENTS SHOWN WITH *, USED ON MCX100 MODELS ONLY.

COMPONENT SIDE ● BD-CEPS-36217-0
SOLDER SIDE ○ BD-CEPS-36218-0
OL-CEPS-36219-B

Schematic, Circuit Board Diagrams, and Parts List for HLN4523B and HLN4775A Microphone and Beeper Boards
PEPS-36482-B
(Sheet 1 of 2)
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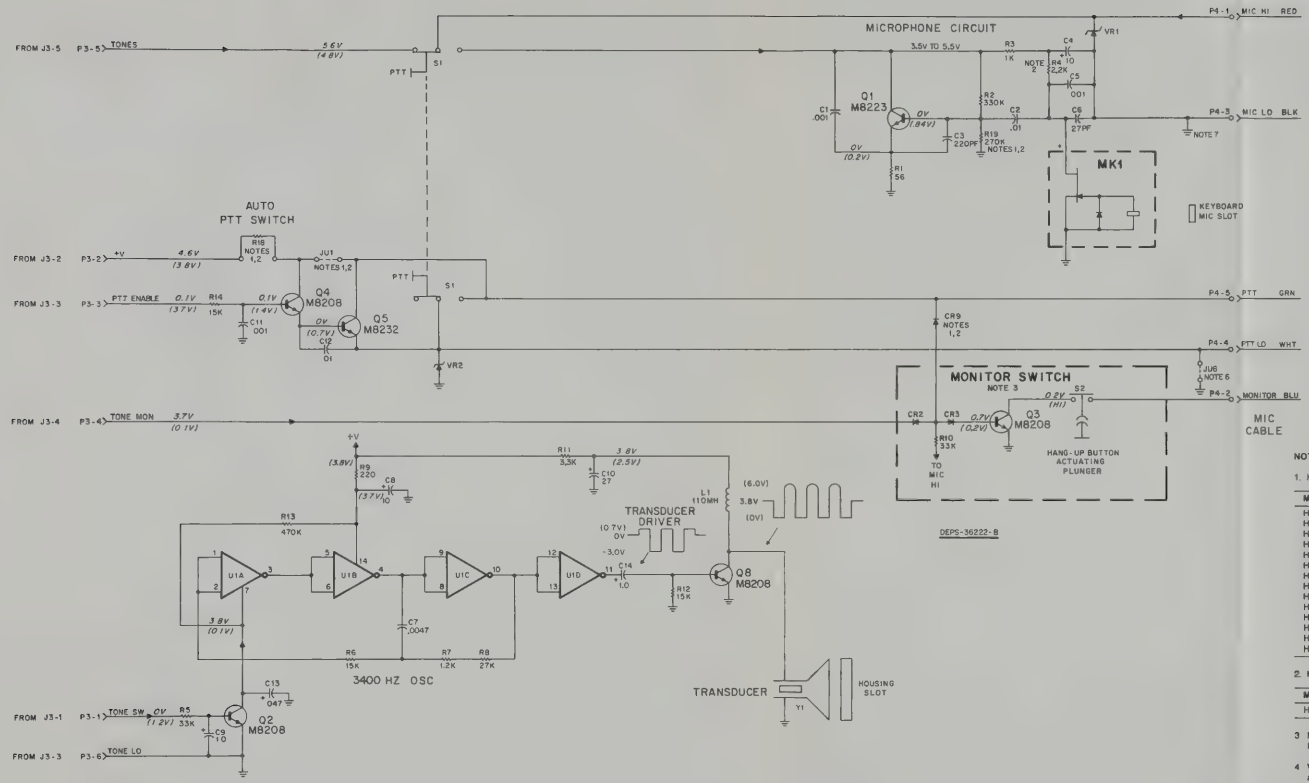
parts list

HLN4523B Microphone and Beeper Board
HLN4775A Microphone and Beeper Board — MXW-2778-O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		capacitor, fixed, μF ±10%, 50V unless otherwise stated
C1	21-11032A09	.001
C2	08-11051A07	.01 ±5%, 63V
C3	21-11031A47	220 pF ±5%, 50V
C4	23-11013D13	10, 20V, tantalum
C5	21-11032A09	.001
C6	21-11031A25	27 pF ±5%
C7	08-11051A05	.0047 ±5%, 63V
C8	23-11013D13	10, 20V, tantalum
C9	23-11013F57	1 ±20%, 35V, tantalum
C10	23-11013C12	27, 15V, tantalum
C11	21-11032A09	.001
C12	21-11032A21	.01
C13	08-11051A11	.047 ±5%, 63V
C14	23-11013F57	1 ±20%, 35V, tantalum
		diode (see note)
CR2, 3	48-83654H01	silicon
CR9	48-83654H01	silicon (HLN1123B only—see tables on schematic)
		connector plug
J3	09-80237F01	6-pin
		jumper
JU1	08-11009F23	resistor (see tables on schematic)
		coil
L1	24-80108G02	audio 110 mH
		connector receptacle
P4	28-80065E03	male header
		transistor (see note)
Q1	48-80182D23	NPN, type M82D23
Q2–4	48-80182D08	NPN, type M82D08
Q5	48-80182D32	NPN, type M82D32
Q8	48-80182D08	NPN, type M82D08
		resistor, fixed, Ω ±5%, ⅛ W unless otherwise stated
R1	06-11009E19	56, ¼ W
R2	06-11024B10	330k
R3	06-11024A49	1k
R4	06-11024A57	2.2k (HLN4523B only—see tables on schematic)
	or 06-11024A51	3.3k (HLN4775A only—see tables on schematic)
R5	06-11024A85	33k
R6	06-11024A77	15k
R7	06-11024A51	1.2k
R8	06-11024A83	27k
R9	06-11024A33	220
R10	06-11024A85	33k
R11	06-11024A61	3.3k
R12	06-11024A77	15k
R13	06-11024B14	470k
R14	06-11024A77	15k
R18	06-11009E46	750, ¼ W (HLN4523B only—see tables on schematic)
	or 06-11009E53	1.5k, ¼ W (HLN4775A only—see tables on schematic)
	or 06-11009A71	8.2k, ¼ W (HMN1014B only—see tables on schematic)
R19	06-11009B08	270k, ¼ W (see tables on schematic)
		switch
S1	40-80065E02	momentary pushbutton
S2	40-80252E01	contact switch (*MCX-100* models only)
		integrated circuit (see note)
U1	51-80073C08	quad nand gate
		voltage regulator (see note)
VR1, 2	48-80007E07	12V zener

3/24/86

note: For best performance, order diodes, transistors, and integrated circuits by Motorola part number.



NOTES:

1. HLN4523B Microphone and Beeper Board Resistor, Diode, and Jumper Table

MODEL	R18	R19	JU1	CR9
HMN1010B	OUT	IN	IN	OUT
HMN1011B	750 Ω	OUT	OUT	IN
HMN1014B	8.2k	IN	OUT	OUT
HMN1018B	750 Ω	OUT	OUT	OUT
HMN1019B				
HMN1020B	750 Ω	OUT	OUT	OUT
HMN1021B	750 Ω	OUT	OUT	OUT
HMN1022B	OUT	IN	IN	OUT
HMN1023B	750 Ω	OUT	OUT	IN
HMN1024B	750 Ω	OUT	OUT	IN
HMN1025B				
HMN1032A	OUT	IN	IN	OUT
HMN1033A	750 Ω	OUT	OUT	IN
HMN1034A	750 Ω	OUT	OUT	IN

2. HLN4775A Microphone and Beeper Board Resistor, Diode, and Jumper Table.

MODEL	R19	R18	JU1	R4	CR9
HMN1026B	OUT	1.5k	OUT	IN	OUT

3 Monitor switch circuitry in dashed box is operation for Models HMN1023B, HMN1024B, HMN1026B, HMN1032A, and HMN1033A only.

4 Voltages indicated in (0.2V) are active voltages (when either PTT or keypad buttons are pressed). Standby voltages are shown without parenthesis.

5. Unless otherwise indicated, resistor values are in ohms, and capacitor values are in microfarads

6. JU6 is not used

7 The ground symbol on this diagram is actually referenced to microphone low, not to radio ground.

Schematic, Circuit Board Diagrams, and Parts List for HLN4523B and HLN4775A Microphone and Beeper Boards
PEPS-36482-B
(Sheet 2 of 2)
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COMMERCIAL WARRANTY
(STANDARD)

Motorola radio communications products are warranted to be free from defects in material and workmanship for a period of ONE (1) YEAR, (except for crystals and channel elements which are warranted for a period of ten (10) years) from the date of shipment. Parts, including crystals and channel elements, will be replaced free of charge for the full warranty period, but the labor to replace defective parts will only be provided for one-hundred-twenty (120) days from the date of shipment. Thereafter, purchaser must pay for the labor involved in repairing the product or replacing the parts at the prevailing rates together with any transportation charges to or from the place where warranty service is provided. This express warranty is extended by Motorola Communications and Electronics, Inc., 1301 E. Algonquin Road, Schaumburg, Illinois 60196, to the original purchaser only, and only to those purchasing for purpose of leasing or solely for commercial, industrial, or governmental use.

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This warranty is void if:

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b. the product has been subject to misuse, accident, neglect, or damage;
c. unauthorized alterations or repairs have been made, or unapproved parts used in the equipment.

This warranty extends only to individual products, batteries are excluded, but carry their own separate limited warranty. Because each radio system is unique, Motorola disclaims liability for range, coverage, or operation of the system as a whole under this warranty except by a separate written agreement signed by an officer of Motorola.

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In order to obtain performance of this warranty, purchaser must contact its Motorola salesperson or Motorola at the address first above shown, attention Quality Assurance Department.

This warranty applies only within the United States.

MXW-0378-O

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MXW-0379-O

MOTOROLA INC.

Mobile Products Division
5555 North Beach Street
Fort Worth, Texas 76137

Touch-Code Encoder
Palm Microphone

68P81114E07-B